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Original Research Article

Diagnostic capabilities of the vestibular evoked myogenic potential test in children with vestibular dysfunction

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ABSTRACT

Background: Vestibular evoked myogenic potential (VEMP) testing is used in the diagnosis of vestibular disorders. It is an objective method for testing the the otolith organs of the vestibular system. VEMP test is an additional method for diagnosing vestibular neuritis (VN). The combination of cervical VEMP (cVEMP) and ocular VEMP (oVEMP) testing has an advantage in long-term monitoring of patients with VN. The VEMP test is well-studied for adults but studies involving children are insufficient. The aim of this study was to analysis and evaluation of the results from VEMP testing of children diagnosed with vestibular dysfunction. Analysis and evaluation of the results from VEMP testing of children diagnosed with vestibular dysfunction.
Methods: History, examination of ENT organs, tone threshold audiometry, tympanometry, otoneurological examination, VEMP test.
Results: Children with vestibular dysfunction who were examined showed changes predominantly in the oVEMP test. The upper branch of the vestibular nerve is affected.
Conclusions: The VEMP test is an additional method for diagnosing patients with vestibular dysfunction. It is safe when used for children.

Keywords: Vestibular neuritis, VEMP test, Child

INTRODUCTION

Vestibular evoked myogenic potential (VEMP) testing is used to diagnose central and peripheral vestibular disorder. It assesses vestibular function through the reaction of the reflex muscle in response to high-intensity acoustic stimulation. The VEMP examination is an objective method for neurophysiological assessment of the otolith organs of the vestibular system. VEMP is well-studied for adults but studies involving children are insufficient. Its sensitivity varies depending on the condition of the middle ear, pathological conditions of the spine, presence of muscle weakness, age, body weight.[1]

The VEMP test is an additional method for diagnosing vestibular neuritis (VN).[2] The combination of cervical VEMP (cVEMP) and ocular VEMP (oVEMP) testing has an advantage in long-term monitoring of patients with VN. Based on investigations by Goebel et al., in 2001, it was found that the upper branch is affected more often. The upper branch passes through a long and narrower tunnel in the temporal bone. This makes it more sensitive to inflammation.[2] It has been found that in only 34% of patients with vestibular neuritis there are changes in the click-induced VEMP on the damaged side.[3] Other authors report that VEMP registers changes in patients with unilateral vestibular hypofunction in 63.63% of cases. Of these, unilateral abnormal VEMP is registered in 48.48% of cases, bilateral changes are resisted in 15.15% in the

VEMP test.[4] According to studies, 43.30% of patients with vestibular hyporeflexia have changes both in the cervical tract and the ocular VEMP.[5] In 57% of these, abnormalities are resisted in the cervical VEMP and in 63% changes are found in the oVEMP test. The analysis of responses to the combined cervical and ocular VEMP test shows results which complement the diagnosis.[5] Various parameters are abnormal in the VEMP test of patients diagnosed with vestibular neuritis (lack of typical wave on the involved side, increased latency and reduced amplitude of the p13-n23 complex or the n10 wave on the involved side).

Childhood vertigo represents 1% of consults in medical neurology and 13% of children referred for audiologic evaluation. This percentage is likely higher. The otoneurologist has difficulties obtaining an adequate history and performing an otoneurological examination of children in order to establish the right diagnosis.[6] By stimulating the ear with high-intensity sound, cVEMP has been successfully recorded in newborns aged 3-5 days. oVEMP can be registered in children aged two years and older.[7]

The VEMP test in children is characterized by some specific features. In children, wave latencies are shorter and amplitudes are smaller than those, obtained in adults.

When examining children aged between three and twelve years using cVEMP, it has been found that latencies are shorter (p1-11.5ms, n1-18.4ms from a study) and amplitudes are lower than those in adults. With increasing age, the amplitudes and peaks at p13 and n23 increase and the latency of n23 goes up for cVEMP. Children aged 11-12 years demonstrate latency comparable to that of adults.[8] The influence of age on the wave amplitude of the cVEMP test is probably related to the changes in the thickness of the musculus sternocleidomastoideus. Older children with better developed muscles have higher amplitudes p13 and n23 latencies with cVEMP in children are significantly correlated with age, head circumference, height and body weight.[6] It is preferable to perform the cVEMP test after the age of three months. It is necessary for the childs neck muscles to develop so that it can support its head. The cVEMP test registers the biphasic waveform (+) positive p13 wave with a latency of 13 ms, followed by a (-) negative n23 wave with a latency of 23 ms.

oVEMP are registered in childhood over the age of two. The latency and amplitude of the oVEMP wave do not differ significantly from those of adults unlike cVEMP. The oVEMP test registers the biphasic curve (-) negative n10 wave followed by a positive (+) p15 wave.

Vestibular dysfunction may affect both the upper and the lower branch of the vestibular nerve. In some patients, both branches of the vestibular nerve are affected, changes are found in oVEMP and cVEMP tests.

Analysis and evaluation of the results from VEMP testing of children diagnosed with vestibular dysfunction.

METHODS

Study design

In this study our tasks are following up on the results of the VEMP test in children with vestibular dysfunction. Comparing the changes in the VEMP test of the first examination against the results obtained at the follow-up examination following treatment. Comparing the results from the VEMP test between the two age groups. Exclusion criteria: inflammation of the middle ear, reduced hearing, central vertigo.

Study place and period

VEMP testing was conducted at the otoneurological medical office of the ENT clinic at UMHAT Sveti Georgi in the city of Plovdiv, Bulgaria. Children aged 6 to 18 years with unilateral vestibular dysfunction were followed-up over the period from May 2018 through April 2019.

Selection criteria of the patients

The subject of the study are 18 children aged 6 to 18 years with vestibular complaints or evidence of a vestibular crisis, referred by a pediatrician or pediatric neurologist after exclusion of a central otoneurological syndrome.

Examined children were divided in two groups according to their age. The first group consists of seven children aged 6 to 12 years - six girls and one boy, and the second group consists of eleven children aged 13 to 18 years -7 girls and 4 boys.

All followed children had vestibular complaints. The parents of three children from the first group and seven of the second group reported a history of a virus infection and treatment. One of the children- a girl aged 17 reported irregular menstruation and having booked an appointment with a gynecologist. There were no pathological findings during the examination of the ENT organs.

Prior to vestibular evoked myogenic potentials testing, tone threshold audiometry and tympanometry with acoustic reflex were performed to rule out conductive hearing impairment.

The tone threshold audiometry in all children found socially adequate hearing. Tympanometry indicated a tympanogram type A.

Otoneurological examination

One child showed spontaneous nystagmus under Frenzel goggles, and the others - evoked nystagmus with a head shaking test. Deviations in the statokinetic tests were found for all children.

Procedure

Before the VEMP test, the parents (guardians) complete informed consent forms. They were provided detailed information about the study and its contribution to the diagnostics of vestibular disease.

An eVEMP usb BioMed computer system was used for the VEMP test. VEMPusb is a comprehensive system for testing otolith organs. The system consists of: eVEMPusb - the device is used to record EMG signals, generate stimulation tones and transfer the data via USB. eVibration usb - biofeedback device for muscle tone control during the VEMP test. Color-coded electrode cables: these are used in combination with wet electrodes to record EMG signals.

Prior to performing the VEMP test patient data are recorded. During the test the patient lies down on the couch. During the cVEMP test, the two active electrodes were positioned symmetrically on the middle third of the two musculus sternocleidomastoideus. The reference electrode was placed suprasternally, and the ground one on the forehead. Monostimulation was used with the sound wave conducted through headphones placed tightly on the ears. Both ears were examined one after the other. The patient raises their head at 30 degrees to the body in order to flex the neck muscles and to activate the musculus sternocleidomastoideus. Vestibular evoked myogenic potentials are registered by the electrodes placed on musculus sternoclleidomastoideus. With the cVEMP test 100 stimuli were registered and averaged. EMG activity was monitored. The examination was stopped if there was no muscle activity. Following the cVEMP test, the results were stored.

For the performance of oVEMP, active electrodes were positioned under the eyes, the reference ones 1-2 cm below these and the grounding one - on the forehead. The patient raises their eyes up. With oVEMP 200 stimuli were registered and averaged.

The recorded test results are displayed on the monitor in four diagrams (two for cVEMP left or right and two for oVEMP left or right). The results of the VEMP test are specific. If there are recorded waves, sacculus and utriculus are intact.

For the cVEMP test, sound stimulation through the headphones or via the bones through vibrations is used to read the status of macula sacculae, the lower vestibular nerve and the vestibulosaccular paths with the aid of the electrodes. For the oVEMP test, the patient looks up. oVEMP is a test for macula utriculae. It records the status of macula utriculae and the upper branch of the vestibular nerve of the contralateral side of the electrodes. When performing the VEMP examination we used an auditory stimulus (click) 10 ms with an intensity of 110 dB and frequency of 500 Hz.

cVEMP is presented by a biphasic wave. The first wave has a positive peak with mean latency 13ms.-p13 wave followed by a negative peak with mean latency 23 ms, -n23 wave, biphasic wave p13-n23 (16). A biphasic n-p is registered in the oVEMP test. The first biphasic potential has a negative (-) peak with mean latency 10 ms -n10 wave, followed by a positive (+) peak of the wave with mean latency 15 ms-p15 also known as n10-p15.

The study was approved by the ethics committee at the medical university of Plovdiv. The capabilities of graphic analysis are used to showcase the phenomena.

RESULTS

Results from the VEMP test

In the first group (7), normal cVEMP curves were registered in five children. Changes were found in the cVEMP examination of the other two children. A wave with an extended latency was registered in one child for one ear, and for the second child waves with an increased amplitude ratio were registered. Deviations were registered in the oVEMP test of all seven children. Atypical waves were registered for one ear, waves with an increased ratio were registered in three, a n10-p15 wave with increased latency was recorded in one ear for one child. Deviations in cVEMP and oVEMP were registered in two children from the first group.

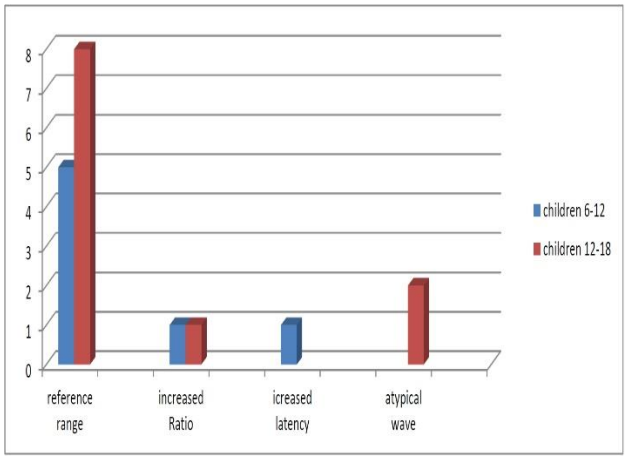

Figure 1: cVEMP test in the first study.

No deviations were found in the cVEMP test of eight children (out of 11) from the second group. For one child, waves with an increased amplitude ratio of over 35% were registered, an atypical curve was registered in one ear for two children.

The oVEMP test performed on the second group of children demonstrated different types of changes. For 4 children, atypical waves were registered in both ears, for 4 children waves with an increased ratio - over 35%, for two children a unilateral atypical wave was registered, and one child had a n10-p15 wave with an extended latency in one ear. For 8 children deviations were registered only in the oVEMP test. For three children deviations were registered both in the cVEMP and the oVEMP test.

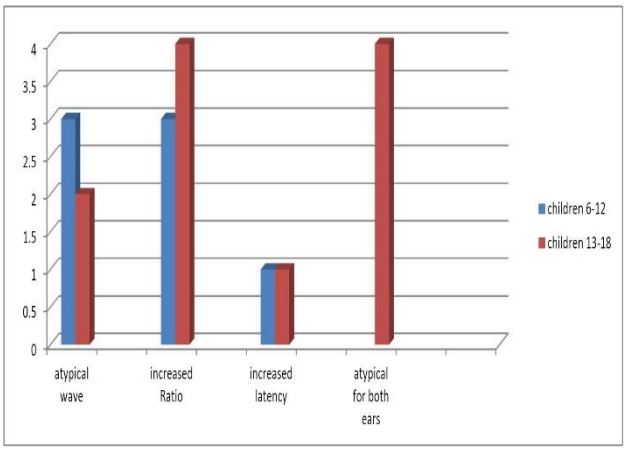

Figure 2: oVEMP test in the first study.

In all children, during the first examination, deviations were registered in the oVEMP test and the upper branch of the vestibular nerve was affected. The changes in the VEMP test of the two groups of children were followed up one month later.

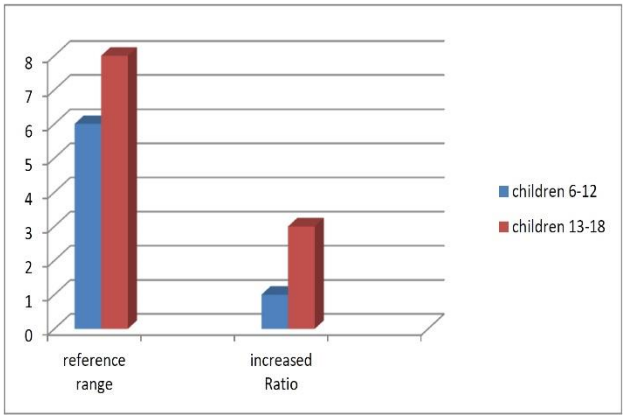

Figure 3: cVEMP test result after one month.

The history of all children shows an improvement in their condition. The otoneurological examination did not find nystagmus and deviation in statokinetic tests. The cVEMP registered typical waves for six children from the first group - biphasic curve with (+) p13 wave and a subsequent (-) n23 wave. In one child, an increased ratio was registered, analogically to the result a month earlier. The oVEMP test of six children found changes in the same ear. An atypical wave was registered for one ear for 4 children, an increased Ratio was recorded for 2 children. A normal n10-p15 was registered for one child. One child from the first group had typical bilateral curves for cVEMP and oVEMP. Changes in cVEMP and oVEMP were registered for one child. In the second group, normal waves were registered for eight of the children during cVEMP. Three children had two-wave curves with increased amplitude ratio of over 35%.

The oVEMP examination of three children in the second group found typical curves bilaterally and changes were registered in the remaining eight. Four of these demonstrated pathological curves for the same ear. For two of the children, pathological curves were registered for both ears with a pathological wave registered only for the left ear during the first examination of one of these children. For two of the followed children the oVEMP test found and elevated amplitude ratio -35%. For three children in the second group deviations were found in the cVEMP and oVEMP test. Typical curves were found bilaterally with both tests in three children.

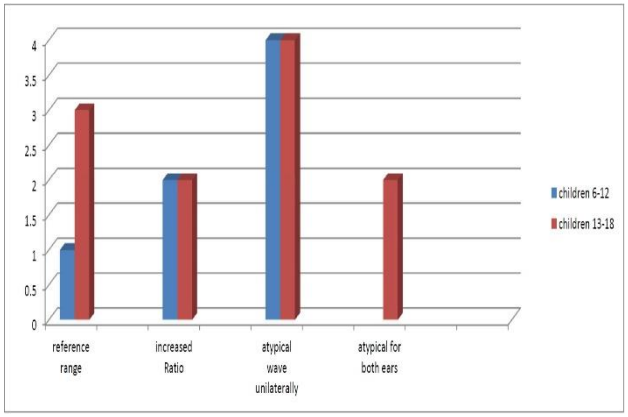

Figure 4: oVEMP test result after one month.

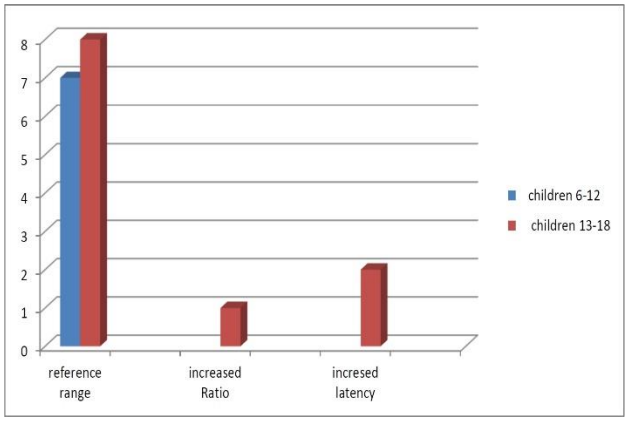

Figure 5: cVEMP test result after three months.

After a month, in both age groups, deviations were observed mainly in the oVEMP test. As part of the follow-up it was noted that the results from the oVEMP test during the first examination found deviations in all children, while one month later typical n10-p15 were

registered in four children. After three months, an otoneurological examination was performed as well as a VEMP test.

The otoneurological examination of only one 14-year-old child with vestibular complaints found deviations in the statokinetic tests in the direction opposite the stimulated labyrinth. Spontaneous nystagmus was seen under Frenzel goggles in the direction of the stimulated labyrinth. No deviations were found in the cVEMP tests. The oVEMP test found an atypical wave in one ear (the stimulated labyrinth). The result from the oVEMP test was identical to the result from the previous examination. Nystagmus and deviations in the statokinetic tests were not found in any of the other children subject to follow-up.

When performing a cVEMP test, for the children aged six to twelve years normal p13-n23 waves were registered. Three children in the first group had normal waves in the oVEMP test, while deviations were found in the rest. Three children in the first group showed typical curves bilaterally.

Typical biphasic curves were registered in the cVEMP test of eight children from the second group. In the other three, changes were registered, for two children there was increased latency in one ear and for one child increased ratio. The oVEMP examination of three children found typical waves.

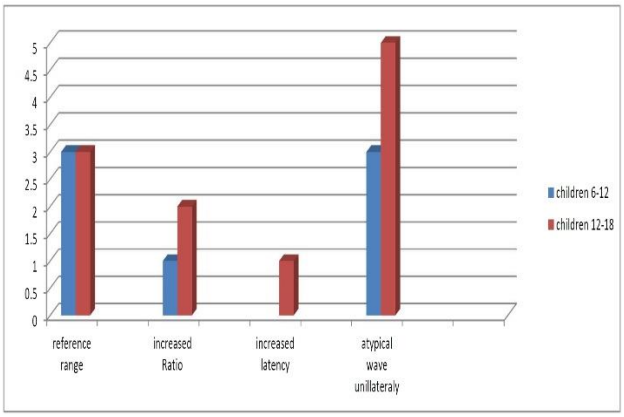

Figure 6: oVEMP test result after three months.

Typical curves were registered bilaterally in three children from the second group. During the VEMP test after three months there were mainly changes in the oVEMP examination.

DISCUSSION

The examined children aged 12 to 18 years with vestibular dysfunction showed changes in the VEMP test. The vestibular evoked myogenic potentials test is also abnormal in patients with unilateral vestibular dysfunction.[4] VEMP has a role for establishing diagnosis and prognosis of patients with vestibular dysfunction.[2] The combination of cVEMP and oVEMP testing has an advantage. The VEMP test is an additional method for diagnosing vestibular dysfunction.

The VEMP examination of the children aged 6 to 18 years with vestibular dysfunction showed changes predominantly in the oVEMP test. The upper branch of the vestibular nerve is affected. Mostly a unilateral atypical wave and deviations in the amplitude resistance were registered. In patients with vestibular dysfunction alterations are predominantly registered in the oVEMP test. In addition to the functional differences, the two branches of the vestibular nerve differ significantly in terms of pathway anatomy. The upper branch is more sensitive to inflammation.[2,5]

The VEMP test of patients diagnosed with vestibular dysfunction can register various deviations.[4] When following-up on patients with VN after one year, 71.4% of these have recovered to normal values in all tests with regression of vestibular symptoms. High oVEMP asymmetry reflects predominantly a utricural lesion.[9]

Following up on the results, obtained using the VEMP test during the first examination, one month and then three months later, it was found , that these are in sync with the improvement of the subjective condition of the children. When testing children aged 12-18 years, the results were analogous to those in adults. Children aged over 12 years have an amplitude and latency in VEMP waves comparable to that of adults.[8,7] The results of the cVEMP and oVEMP tests did not show any significant difference between the two groups of children.

CONCLUSION

The examination of the vestibular analyzer and finding deviations in its function is a complex task for the clinician. The use of new, modern examination methods aids the otoneurologist in establishing a more precise diagnosis. The VEMP test is relatively easy to perform. It is an additional method for diagnosing many peripheral vestibular disorders and neurological diseases, and for their subsequent prophylaxis. It can be used for vestibular assessment of otoneurological disease in children and adults. The VEMP test is safe for children. It can be used as a screening test for vestibular function.

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Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Zhou WG, Dargie JBS, Dornan B, Whittemore K. Monitoring Editor Jorge Pinto Clinical Uses of Cervical Vestibular-Evoked Myogenic Potential

Testing in Pediatric Patients. Med (Baltimore). 2014;93(4):37.
2. Adamec I, Skoric MK, Handzic J, Barusic AK, Bach I, Gabelic T, Habek M. The Role of Cervical and Ocular Vestibular Evoked Myogenic Potential in the follow up of Vestbular Neuritis. Clin EEG Neurosci. 2014;45(2):129-36.
3. Brantberg K, Tribukai A, Fransson PA. Vestibular evoked myogenic potencials to skull taps for patiens with vestibular neuritis. J Vestib Res. 2003;13:121-30.
4. Serra AP, Dorigueto RS, Almeida RR. Vestibular myogenic potential in unilateral vestibular hypofunction. Acta Oto-Laryngo. 2012;11(7):732-8.
5. Silva TR, Resende ML, Santos MAR. Combined ocular and cervical vestibular evoked myogenic potential in individuals with vestibular hyporeflexia and in patients with Menier's disease. Braz J Otorhinol. 2017;83(3):330-40.
6. Pereira AB, Silva MGS, Assuncao ARM, Atherino CCT, Volpe FM, Felipe L. Cervical vestibular evoked myogenic potentials in children. Braz J otorhinol. 2015;81(4):358-62.
7. Wang SJ, Hsieh WS, Young YH. Development of Ocular Vestibular-Evoked Myogenic Potentials in Small Children. The Laryngos. 2013;123:512-7.
8. Danasoury EL, Serafy GE, Taha H, Hegazy S. Vestibular evoked myogenic potentials (VEMP) in young children: Test parameters and normative data. Egiptian J oj ENT and Allied Sci. 2015;16:81-5.
9. Rosengren SM, Welgampova MS, Colebatch GM. Vestibular evoked myogenic potentials: past, present and future. Clin Neurophys. 2010;121:636-51.

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