

Analysis of Saccular Function With Vestibular Evoked Myogenic Potential Test in Meniere's Disease

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Abstract- Meniere's disease is the disorder of inner ear characterized by vertigo, tinnitus and sensorineural hearing loss. The vestibular evoked myogenic potential (VEMP) test could be useful in the analysis of saccular function, and diagnosis of Meniere's disease. In this study, we've analyzed the saccular function, using VEMP test in different groups of Meniere's disease. Patients were categorized as possible, probable or definite Meniere's disease groups according to the guideline of American Academy of Otolaryngology-Head and Neck Surgery. The exclusion criteria were neuromuscular system diseases, diseases of central nervous system, inner ear disorders, conductive hearing loss, a history of ototoxic drug consumption, being a drug abuser and a positive history of inner ear surgery or manipulations. The VEMP test is the recording of positive and negative waves from sternocleidomastoid muscle that is made by an auditory click to the ear. From the total of 100 patients, the waves of VEMP test was seen in 59 patients which 19 patients had abnormal amplitude, and latency and 40 patients were with normally recorded waves. There was a significant relationship between the severity of hearing loss and a VEMP test without any recorded waves. Most of the cases with 'no wave recorded' VEMP test, were patients with severe hearing loss. However, there wasn't any relation between the pattern of hearing loss and 'no wave recorded' VEMP test. VEMP test could be a valuable diagnostic clue especially in patients with definite Meniere's disease.

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Introduction

Meniere's disease is the disorder of inner ear which is characterized by episodes of vertigo, tinnitus and sensorineural hearing loss and caused by dysfunctions in vestibular and cochlear systems. Its average prevalence in populations is 19-24% (1). It has been reported that the disease has a prevalence of 3.5 cases in 100000 people in the Japanese population and 5.3 cases out of 100000 in finish population, so it has a higher prevalence in white people (2). There is no accurate number for the prevalence of bilateral Meniere's cases, and it is reported from 2 to 78% in different studies. These different results are usually because of different diagnostic criteria for the disease and different follow-up periods (3). The pathogenesis of the disease is the endolymphatic hydrops, and the most acceptable theory is the insufficient absorption of endolymph by endolymphatic sac. Presacculary fibrosis and decrease in the size of the endolymphatic sac are possible

histopathologic causes (4). Several studies have proven the hyperplasia in endolymphatic sac and endolymphatic duct. Patients with Meniere's disease have smaller endolymphatic drainage system (5). It has a higher prevalence in ages 40-50, but people of all ages can be involved. It has an equal prevalence in male and female. Imaging studies have clarified that in this disease, the endolymphatic drainage system is inefficient and some studies have also proven the hyperplasia of endolymphatic sac and duct. The American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) criteria for the diagnosis of Meniere's disease is consist of vertigo, tinnitus and hearing loss. These three signs and symptoms are the diagnostic clues for Meniere's syndrome, and if there is a known cause of the symptoms and signs, this is called Meniere's disease. The patients were categorized as possible, probable, definite and certain disease regarding AAO-HNS criteria. There are different diagnostic tests such as pure tone audiometry (PTA), electronystagmography, and

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electrocochleography; but each one has its own weaknesses. It has been suggested recently that the VEMP test could be useful in the analysis of saccular and vestibulospinal tract function, detecting pathologies in inferior vestibular nerve and diagnosis of the Meniere's disease. Saccular afferents stimulate VEMP response and this disease in early stages, affects saccular function, so this is obvious that the altered saccule has different function and will cause changes in VEMP test result (6). The VEMP test results were recorded in 98% of healthy ears and are absent in 51-54% of patients with Meniere's disease (7,8). There is also reported that VEMP test results in the healthy ear of the patients are similar to affected ear, so the VEMP test not only can determine the site of the disease but also can determine the presymptomatic hydrops and can be useful in the analysis of bilateral cases (9). In this study, we analyzed the saccular function using VEMP test in patients with Meniere's disease. The test results would be different regarding the severity of hydrops and hearing loss, so the VEMP test would show different results in different groups of patients. In our study, the VEMP test results in different groups of patients were analyzed regarding their age, sex, type of hearing loss and severity of it.

Materials and Methods

In our cross-sectional study, we first selected a group of 30 patients with Meniere's disease to do a pilot study, because we didn't know the exact prevalence of the disease for each subgroup. Then we increased the number of patients to 100. Our inclusion criteria had vertigo, hearing loss and tinnitus. Patients with this clinical presentation who came to our medical center during a one-year period (2011-2012) were selected. After the diagnosis of Meniere's disease regarding AAO-HNS criteria, the patients were categorized as possible, probable or definite disease, a complete history was taken, and physical examination was done. Exclusion criteria were neuromuscular system diseases, diseases of the central nervous system, middle ear diseases and serous otitis, conductive hearing loss, ototoxic drug consumption, being a drug abuser, middle ear surgery or inner ear manipulations.

At first, data of the patients including their age, gender, and chief complaint, time of the first symptom, disease duration, family history of the disease, and history of migraine, drug history and comorbidities were gathered. We also recorded the exact results of the audiometry for each patient including frequency, the severity of the hearing loss, word recognition score

(WRS), speech reception threshold (SRT), pressure of the middle ear, positive or negative stapedius reflex and tympanogram results. After categorizing patients in different groups, the VEMP test which is the recording of positive or negative P13N23 waves of the sternocleidomastoid muscle, stimulated by an auditory click to one ear, was done by an audiologist. We analyzed the saccular function in different groups of patients and also analyzed the results statistically. Possible relations between different parameters were studied using Pearson chi-square test and the Fisher's exact test. The significant statistical difference was considered as $P < 0.05$.

Results

This study was done on 100 patients with Meniere's disease who came to ENT clinic in Amir-Alam hospital during years 2011-2012. 71 patients were female, and 29 were male. The youngest patient was 16, and the oldest was 72-year-old. The average age of all patients was 43 ± 12.7 years. Only one patient had a positive family history of Meniere's disease. 35 patients had disease duration of less than one year, 48 patients were involved for 1-5 years, 12 patients had the disease for 5-10 years, and 5 patients were involved for more than 10 years. The average number of the disease duration was 3.5 years. 62 patients had unilateral involvement, and 38 had had bilateral disease. 14% of the patients had mild hearing loss while 86% were with intermediate or severe hearing loss. 36 patients had hearing loss in low frequencies, 27 patients in high frequencies and 37 patients had hearing loss in all frequencies. In our 100 patients, 4 were categorized as possible disease, 30 with probable disease and 66 patients with definite Meniere's disease. The VEMP test was recorded in 59 patients, and it was absent in 41 cases. Among 59 patients with recorded VEMP test, 19 had normal amplitude, and latency and 40 patients had abnormal test results.

There was a significant relation between absent VEMP test result and the severity of the hearing loss. Most of the cases with absent VEMP test result had severe hearing loss (Table 1).

There was not a statistically significant relation between the pattern of hearing loss and the absent VEMP test result ($P=0.629$).

We found a significant association between the higher possibility of having the disease and an absent VEMP test result. Most of the cases with an absent VEMP test result were categorized as patients with definite disease (Table 2).

There was a significant relation between the disease duration and abnormalities in VEMP test results. Most of the patients with abnormal test results had a disease duration of more than 5 years ($P=0.007$).

There was not any relation between the type of hearing loss regarding involved frequencies and the

latency and amplitude of the waves in VEMP test results. But there was a significant relation between the disease's subgroups (regarding AAO-HNS criteria) and the VEMP test results. Most of the patients with abnormal test results had the definite disease (Table 3).

Table 1. Severity of hearing loss in patients with absent VEMP test result

Severity of hearing loss	Frequency	Percentage
Low	5	12.2%
moderate	15	36.6%
high	21	51.2%

$P.value=0.008$

Table 2. Frequency of absent VEMP test in relation with Meniere's subgroups

Subgroups of meniere's disease	Frequency	Percentage
Possible	1	2.4%
Probable	6	14.7%
Definite	34	82.9%

$P.value<0.001$

Table 3. Frequency of patients with abnormal VEMP test in relation with Meniere's disease subgroups

Subgroup of meniere's disease	Frequency	Percentage
Possible	2	5
Probable	14	35
Definite	24	60

$P.value<0.001$

Discussion

Meniere's disease is the disorder of inner ear that is caused by genetic and environmental factors (1). The AAO-HNS criteria for the diagnosis of the disease are vertigo, hearing loss and tinnitus. These three symptoms and signs are suggestive of Meniere's syndrome, but if there is a certain cause for them, this is called Meniere's disease (10). Viral infections are suggested as a possible cause of the disease (11). But no specific virus has been proven to be the cause, and different studies could not prove the herpes virus's role in the disease (12). Studies on patients' temporal bone have shown hydrops and tears in the labyrinthine membrane in cochlea and saccule (13). Hearing loss in patients with Meniere's disease is a fluctuating and progressive process. Hearing loss patterns are reported as fluctuating in low frequencies and non-fluctuating in high frequencies (14). Hearing loss in 1-2% of patients progresses to profound

hearing loss. Tinnitus is usually non-pulsatile and can be intermittent or persistent. There is no specific diagnostic test for the disease, and despite the long history of knowing the disease and its clear signs and symptoms, there are problems with its diagnostic ways. There are several suggested diagnostic tests like PTA, electronystagmography, and electrocochleography, but each one has its own problems and limitations. Caloric tests can only determine the involved ear, and the test results are decreased in 48-73.5% of the patients (15). In electronystagmography in patients, the summing potential (SP) will be negative, and the ratio of SP to action potential (AP) will be greater in number. But this test won't accurately diagnose the cause of the disease, and these changes are only positive in 62% of the patients (16,17). Saccule is the second common site for pathologic hydropic changes in patients' temporal bone. The most common site of the hydropic changes is cochlear (18,19). In our study, 100 patients with

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Meniere's disease who came to our medical center between 2011 to 2013 were analyzed. The VEMP test was recorded in 59 patients, and the test result was absent in 49. Among 59 patients with recorded VEMP test, 19 had morphologically normal waves and in 40 (67.8% of the patients) waves were morphologically abnormal. Most of the cases with absent VEMP test were female ($P=0.001$), older than 50 ($P=0.013$), with the disease duration of 1-5 years ($P=0.029$), with severe hearing loss ($P=0.008$) and with definite Meniere's disease ($P=0.000$).

There was said in former studies that patients with hearing loss in higher frequencies will have normal VEMP test results, because the involved area is far from saccule and patients with hearing loss in lower frequencies would have an abnormal VEMP test, but in our study there was not a statistically significant relation between morphology of the recorded waves in VEMP test and frequency of the hearing loss. Former studies have reported that the VEMP test is not recorded in the healthy ear of the patients, but there were not an accurate percentage of the patients with this feature. In our study 14.63% of the patients had an absent VEMP test result in their healthy ear. 41% of the patients had an absent VEMP test result while it was 54% in De Wale's study and 51% in Murofoshi's study (7,8). Many patients with an absent VEMP test were female, and this is compatible with Felip L's study results (20). Most of the cases with morphologically abnormal waves in VEMP test and absent VEMP test result were with the definite disease, and this is compatible with Kim-Lee's study (21).

The same result was reported in Zarei's study (22). Most of the cases with an absent VEMP test result were older than 50, and this is compatible with Jankly's study which reported that the VEMP test response would decrease with increasing age (23). Maybe this result is because of the muscle atrophy and a decrease in muscle force in older people. In our study, most of the cases with absent or abnormal VEMP test results have moderate to severe hearing loss, and this is similar to Taylor's study results. Taylor has reported that abnormal VEMP test results are more common among patients with definite Meniere's disease and the amount of abnormalities are in direct relation to the severity of hearing loss (24).

Despite this point that diagnosis of the Meniere's disease is made by clinical judgment, the VEMP test could be a valuable diagnostic test beside other diagnostic ways in patients with Meniere's disease.

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