Jariengprasert C, et al., J Otolaryng Head Neck Surg 2017, 3: 009
DOI: 10.24966/OHNS-010X/10009

HSOA Journal of Otolaryngology, Head & Neck Surgery

Research Article

The Sensitivity and Specificity of Vestibular Evoked Myogenic Potential (VEMP) in the Diagnosis of Definite Ménière's Disease Patients

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Abstract

Objective

This study was a retrospective review of the data to compare the sensitivity and specificity of cervical VEMP (cVEMP) in unilateral definite Ménière's Disease (MD) patients with those in Vestibular Migraine (VM) and control subjects.

Material and Method

All patients diagnosed as unilateral definite MD and Vestibular Migraine (VM) patients and normal control adults whom underwent cVEMP tests with short tone burst of 500 Hz. at 95 dBHL during January 2007 - December 2015 were included in this study. Age, gender, routine audiometric and cVEMP results were collected. SPSS for windows was used in data analysis; F - test, Chi - square and Fisher's exact test were used for comparison of the means and percentages.

Results

The unilateral definite MD group (22 males, 45 females) had mean age of 50.62 ± 9.41 years and mean Pure Tone Average (PTA) in the affected ears (Rt.ear = 37, Lt. ear = 30) of 45.95 ± 22.58 dBHL. The VM group (5 males, 51 females) had mean age of 49.04 ± 9.85 years and mean PTA in Rt. and Lt. ears of 18.96 ± 7.65 and 19.41 ± 7.96 dBHL, respectively. Normal control adults (13 males, 19 females) had mean age of 45.47 ± 9.54 years and mean PTA on both ears of 16.02 ± 6.28 dBHL. The percentage of abnormal cVEMP result found in the MD group was significantly different from those in the VM (62.68% vs 19.64%; Fisher's exact test, p<0.0001) and control groups (62.68% vs 3.12%; Fisher's exact test, p<0.0001). The sensitivity and specificity of cVEMP in MD were 62.68 and 96.88%, respectively. The percentage of abnormal cVEMP in MD was significantly higher than those in the VM and control groups.

Conclusion

The percentage of abnormal cVEMP in MD was highly significant over those in VM and control groups. Although the sensitivity of cVEMP in unilateral MD was not dominantly better than other vestibular test battery for the diagnosis of MD, these findings supported more saccular dysfunction, the second most often occurred lesion, in MD than in VM group. However, the high specificity (96.88%) of abnormal cVEMP in MD and VM showed non-specific pathology involving the saccule. The results suggested that cVEMP should be used as a confirmative test or for staging of the disease progression to differentiate between MD vs. VM rather than a screening test for detection of hydrops.

Keywords: Cervical Vestibular Evoked Myogenic Potential (cVEMP), Ménière's disease, Sensitivity; Specificity; Vestibular migraine

Introduction

Ménière's Disease (MD) is an inner ear disease, which is characterized by episodic vertigo, fluctuating sensorineural hearing loss, aural fullness, and tinnitus. MD has been diagnosed mainly based on clinical criteria [1]. Laboratory investigations such as Electrocochleography (ECochG), caloric, and glycerol or dehydrating tests [2], however, are helpful in some cases. The sensitivity and specificity of these tests for detecting MD are varied. The ECochG shows sensitivity of 60 to 65% depending on electrode sites [3-6]. A significant reduction of caloric response is found in 48 to 74% of patients with MD [7-10]. In addition, the sensitivity of the glycerol test is reported at 50-60% [11-12]. Each tool has limitation either in site of lesion or unpleasant side effects during the procedure. The cervical Vestibular Evoked Myogenic Potential (cVEMP) has been suggested as being useful in supporting the diagnosis of MD as information of the saccular involvement of the labyrinth, including the pathway from the saccule, inferior vestibular nerve, vestibular nucleus, vestibulospinal tract, through the Sternocleidomastoid (SCM) muscle [13-15].

Vestibular migraine and MD seem to share some similar clinical symptoms and laboratory profiles [16]. Many studies investigated cVEMP sensitivity in Ménière's patients showing various results ranged from 50% to 75% [17-28]. To set our laboratory protocols, this retrospective review in Thai patients aimed to compare the sensitivity and specificity of the cVEMP results in unilateral definite MD patients with those in vestibular migraine patients and healthy controls.

Subjects and Methods

All patients with unilateral definite MD and Vestibular Migraine (VM) who were treated at the Otolaryngology clinic at Ramathibodi Hospital during January 2009 - December 2015 were included. The diagnosis of the MD was defined by the 1995 criteria of the AAO - HNS [1]. The VM patients were diagnosed according to the criteria suggested by Neuhauser and Lempert [16].

The cVEMP data from 32 healthy control subjects described in the previous report were used as normal controls [29]. Each subject gave

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Citation: Jariengprasert C, Ruencharoen S, Reddy NV, Tiensuwan M (2017) The Sensitivity and Specificity of Vestibular Evoked Myogenic Potential (VEMP) in the Diagnosis of Definite Ménière's Disease Patients. J Otolaryng Head Neck Surg 3: 009.

Received: March 14, 2017; **Accepted:** June 07, 2017; **Published:** June 21, 2017

a detailed history and underwent physical examination, a routine audiometry, and the cVEMP tests using 500 Hz tone burst at 95 dBHL as stimulus [29]. The measurement of cVEMP response, which was considered "abnormal," included absent response or abnormal Asymmetry Ratio (AR). The 35% cut - off was used as the upper limit of normal AR response in Thai subjects [29].

Data analysis

SPSS for Windows was used for data analysis in comparison of the percentage and means. Age, gender, and Pure Tone Average (PTA) at 500, 1000, 2000 and 3000 Hz. were collected. The Fisher's exact test (F - test) was used to test for the mean age among different subject groups. The Chi - square test was used to compare the percentages of abnormal cVEMP response among all groups while the Fisher's exact test was used to compare those between two groups. The sensitivity and specificity of the cVEMP results in the MD group and the VM group were investigated and compared.

Results

Table 1 showed the demographic data for each group. No significant difference in age was found among all groups (F - test, p = 0.066). However, the majority of the patients in the VM group were female showing significant differences from those in the MD and control groups (p<0.05). The PTA hearing thresholds in the MD group were significantly higher than those in both the VM and control groups (p<0.001). There was no significant different between the VM and control groups.

Data	MD	VM	Control	P - value
	(n = 67)	(n = 56)	(n = 32)	
Age (mean + SD) years	50.62 + 9.41	49.04 + 9.85	45.47 + 9.54	0.066
Sex - Female (%)	45 (67.17)	51 (91.07)*	19 (59.37)	<0.05
Male (%)	22 (32.83)	5 (8.93)	13 (40.63)	
PTA (mean + SD) dBHL	Affected ears	RE = 18.96 + 7.65	Both ears	<0.001
	45.95 + 22.58*	LE = 19.41 + 7.96	16.02 + 6.28	

Table 1: Demographic data.

MD - Meniere's Disease group, VM - Vestibular Migraine Group, SD - Standard Deviation, PTA = Pure Tone Average, RE = Right Ear, LE = Left Ear

*Significant difference from other groups.

Table 2 shows that 62.68% of the patients in the MD group, compared to nearly 20% of the patients in the VM group, had abnormal cVEMP responses. Only one subject in the control group showed abnormal cVEMP response. The Chi - square test of cVEMP and disease status percentages showed a significant difference at p<0.001. The Chi - square test of these percentages showed significant differences among the three groups (p<0.001). The F-test also show differences between MD vs. VM (p<0.0001), between MD vs. control (p<0.001), and between VM vs control (p<0.05).

The sensitivity and specificity of the cVEMP in the MD group were 62.68%, and 96.88%, respectively, whereas those of the cVEMP in the VM group were 19.64% and 96.88%, respectively.

The Chi - square test did not show a significant difference in the proportion of patients with normal and abnormal cVEMP results based on different stages (p = 0.26, Table 3) and the duration of onset in the MD group (p = 0.30, Table 4). The proportions of individuals with abnormal cVEMP responses, however, appeared to be higher in those at stages 3 & 4 of MD than those at stages 1 & 2. Similarly, the proportions of individuals with abnormal cVEMP responses tended to be higher among the patients with more than 10 years of the disease onset than those with less than 10 years.

cVEMP Results	MD	VM	Control	X^2	p-Value
	n (%)	n (%)	n (%)		
Abnormal	42 (62.68)	11 (19.64)	1 (3.12)	42.76	<0.001
Normal	25 (37.32)	45 (80.36)	31 (96.88)		
Total	67 (100)	56 (100)	32 (100)		

Table 2: Number and percent of patients with normal and abnormal cVEMP results in the MD, VM and control groups.

Stage	Abnormal	Normal	Total	X^2	P - value
	n (%)	n (%)	n (%)		
I	16 (57.14)	12 (42.86)	28 (100)	2.69	0.26
II	16 (59.26)	11 (40.74)	27 (100)		
III & IV	10 (83.33)	2 (16.67)	12 (100)		
Total	42 (62.69)	25 (37.31)	67 (100)		

Table 3: Number and percent of patients with normal and abnormal cVEMP results in different stage of MD.

Duration (years)	Abnormal	Normal	Total	X^2	P - Value
	n (%)	n (%)	n (%)		
≤ 5	21 (60.0)	14 (40.0)	35 (100)	2.408	0.3
>5 - ≤10	14 (58.33)	10 (41.67)	24 (100)		
>10	7 (87.50)	1 (12.50)	8 (100)		
Total	42 (62.69)	25 (37.31)	67 (100)		

Table 4: Number and percent of patients with normal and abnormal cVEMP results based on duration of onset of the MD.

Discussion

The possibility of having a lower cVEMP threshold could be found in other inner disorders, such as dehiscence, perilymph fistula, and BPPV [17,30]. The cVEMP test has been widely used to detect saccular dysfunction. The abnormalities of VEMP findings in patients with MD and VM have been previously reported [16-24,31-35]. The sensitivity of cVEMP was higher in patients with MD than those with VM (62.68 vs. 19.64). On the other hand, the specificity of cVEMP for both groups was the same (96.88 vs 96.88). Individuals with MD were more likely to have abnormal cVEMP responses than those with VM, suggesting that saccular involvement occurs more frequently in the MD group than the VM group. This finding was consistent with that by Egami et al., They reported that cVEMP helped provide the appropriate diagnosis in 50% of 114 MD cases but had a specificity of 48.9% in other vestibular disorders. In the VM group, they reported a higher percentage of abnormal cVEMP than our study (29.3%) [31]. Absent or augmented cVEMP amplitude on the affected ear was found in 54% to 71% of MD patients [18,25,26]. On the other hand, the cohort study from Mexico found a similar reduction of cVEMP amplitudes in both the MD (n = 20) and VM (n = 21) groups [27].

The sensitivity of cVEMP in patients with MD has been reported with various results, ranging from 50% to 75% [17-28]. Various authors have investigated cVEMP in MD and have taken a wide range of parameters into consideration [17-24,28-30]. Rauch et al., [21] studied VEMP recordings from 14 normal individuals compared to those

from 34 patients with MD. They found a significant difference in cVEMP amplitudes among normal ears, unaffected MD ears and affected ears. With the low frequency tone bursts, the cVEMP was presented in all normal subjects but only in 82 - 85% of MD ears. Later, they also studied the clinical assignment of side - of - disease in 20 unilateral Ménière's subjects to side assignment using AAO - HNS clinical criteria and previous audiogram as gold standard compared to cVEMP interaural threshold difference, caloric asymmetry, and multivariate statistical analysis of a vestibular test battery. Their results showed that the accurate method of side assignment scored correctly by 250 Hz. The sensitivity of cVEMP was 80% and that for the click cVEMP was 55% [24]. Taylor et al., combined measurement of cVEMP by using an abnormally low 0.5/1 kHz frequency ratio and/or an elevated 0.5 kHz AR. They found a sensitivity of 75% and specificity of 80% in differentiating MD from VM [30].

Difference in the percentage of abnormal cVEMP results in MD might be due to differences in the protocol of study using TB of 500 Hz that showed less sensitivity of using 1000 Hz. (resonance frequency tuning shift) [30] and also due to the number of study subjects and variation in disease staging. Our study focused on the laboratory protocol, and the 500 Hz tone burst for cVEMP testing was used for other vestibular disorders as well. However, when the test is abnormal, all patients should have some pathology in the saccule, e.g., endolymphatic hydrops or ischemic process.

In MD, the ECochG is aimed mainly to identify cochlear hydrops; meanwhile, a caloric test is used for the detection of horizontal semicircular canal function. The sensitivity of ECochG was about 60-65% using ear tip-trode [3-6] and the sensitivity of acaloric test was about 48 - 74% using 25 - 30% interaural different criterion [7,8,10], while the test using dehydrating agents showed 50 - 60% of sensitivity [11,12]. Although the sensitivity of cVEMP in this present study was not superior to the previous audio-vestibular tests (ECochG, caloric test, dehydrating agent), cVEMP was easier to perform, less uncomfortable, and well tolerated by patients. In addition, the cVEMP test had no risk of hypotension, dizziness, nausea, vomiting, or muscle weakness, in contrast to the test using dehydrating agents or a caloric test. From clinical observations, the ECochG test took more time to operate than the cVEMP test in the same cases. Moreover, it could be performed on patients with severe to profound hearing loss in which the ECochG test was confounded because of its limitation. Hence, the cVEMP test should be included as one of the audio - vestibular test battery for MD or other vestibular disorders suspected for a saccular portion involvement.

A controversy was found in the cVEMP investigation in MD as the percentage of abnormal cVEMP should be greater in more advanced stages of the disease [31,33-35]. Moreover, a saccular involvement showed to have a greater chance of having poor hearing outcome [35]. More importance in identifying abnormal cVEMP on unaffected ear (35%) should alert a physician for possible subclinical hydrops on the good ear [36]. Our study found a higher percentage of abnormal cVEMP in later stages (stage 3+4 = 83.33%) than in earlier stages and also with longer durations of onset (>10 years = 87.5%) than shorter durations; however, this was not statistically significant. There might be variation in a small number of subjects especially in the more severe and longer duration group.

The limitation of this study is a single institutional study with relatively small sample size in each group particularly the control group. However, our findings suggest that the cVEMP shows a fair effect as a screening tool due to a slightly low sensitivity (62.68%) depending on disease staging, but it could be used for identifying saccular involvement in the case of definite MD because of its high specificity (96.88%). The results also suggest that cVEMP should be used as a confirmative test or for staging of the disease progression to differentiate between MD vs. VM patients rather than a screening test for the detection of hydrops. Further study should be investigated for more information regarding the exact parameter which could improve the cVEMP testing protocol.

Conclusion

The usefulness of the cVEMP test for assessing saccular function in MD has been widely reported. This study found that the sensitivity and specificity of the cVEMP in patients with unilateral definite MD were 62.68%, and 96.88%, respectively. The sensitivity of the cVEMP test in the MD group was significantly higher than in the VM (19.64%) and control (3.12%) groups. These findings suggest that the MD group shows a more saccular involvement than the VM group. Also, we found that the VEMP test was not more sensitive than the ECochG, caloric and dehydrating tests. Higher percentage of cVEMP abnormality was found in patients who suffered for a longer duration and a higher level of severity, indicating more saccular involvement. Thus, the cVEMP test should be used as a confirmative test or for staging disease progression to differentiate between patients with MD and VM rather than just as a screening test for the detection of hydrops.

Acknowledgement

The authors gratefully acknowledge Mr. Kongpol Euasirirattanapaisan for providing the data of the control subjects, Mr. Weerapat Punkla for statistical analysis support and Miss Alongkot Emasithi for her linguistic support in the preparation of this article.

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