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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 retrospectively reviewed the data to compare the sensitivity and specificity of cervical VEMP (cVEMP) between unilateral definite Ménière's disease (MD) patients, vestibular migraine (VM) and control subjects.

Material and Method: all patients diagnosed as unilateral definite MD, 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 package for Microsoft was used in comparison of the percentage and means.

Results: the unilateral definite MD group (22 males, 45 females) had mean aged 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 aged 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 aged 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 MD was significantly different from those in VM (62.68 vs. 19.64%; X2=23.097, p=0.000) and control group (62.68 vs. 3.12%; X2=31.271, p=0.000). The sensitivity and specificity of cVEMP in MD were 62.68 and 96.88%, respectively.

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 dominant than other vestibular test battery in 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 or either in differentiation between MD vs. VM patients, rather than a screening test for detection of hydrops.

Keywords: Cervical vestibular evoked myogenic potential (cVEMP); Ménière's disease; Vestibular migraine; Sensitivity; Specificity

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Introduction

Although, the diagnosis of Ménière's Disease (MD) is based on clinical criteria [1], in some cases laboratory investigations which have potential in the diagnosis of MD are needed. Standard tests widely used in clinical applications are Electrocochleography (ECochG), caloric test, glycerol and dehydrating test [2]. Their sensitivity and specificity in MD seem to be 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 unpressant side effects in the procedure. The cervical vestibular evoked myogenic potential (cVEMP) may be useful in supporting the diagnosis of MD as an information of the saccular involvement of the labyrinth, including the pathway from the saccule, inferior vestibular nerve, vestibular nucleus,

Table 1: Demographic data.

Data	MD	VM	Control	*p-value*
Mean age (SD) years	50.62 (9.41)	49.04 (9.85)	45.47 (9.54)	0.066
N / female (%)	67/45 (67.17)	56/51 (91.07)	32/19 (59.37)	-
Mean PTA (SD) dBHL	Affected ears 45.95 (22.58)	RE=18.96 (7.65) LE=19.41 (7.96)	Both ears 16.02 (6.28)	-

PTA: Pure Tone Average; RE: Right Ear; LE: Left Ear

Table 2: Percentage of abnormal cVEMP results in MD, VM and control groups.

VEMP results	**Disease status**						X^2	*p-value*
	MD		VM		Control			
	n	%	n	%	N	%		
Abnormal VEMP	42	62.68	11	19.64	1	3.12	42.761	0.000
Normal VEMP	25	37.32	45	80.36	31	96.88		
Total	67	100	56	100	32	100		

Table 3: Percentage of abnormal cVEMP results in MD and VM groups.

VEMP results	**Disease status**				X^2	*p-value*
	MD		VM			
	n	%	n	%		
Abnormal VEMP	42	62.68	11	19.64	23.097	0.000
Normal VEMP	25	37.32	45	80.36		
Total	67	100	56	100		

vestibulospinal tract, through the sternocleidomastoid (SCM) muscle [13-15].

Many studies investigated cVEMP in Ménière's patients have shown various results [16-23]. The aim of this study was to compare the sensitivity and specificity of the cVEMP between unilateral definite MD patients and vestibular migraine patients and healthy control group.

Subjects and Methods

The subjects included in this study were unilateral definite Ménière's Disease patients (MD), Vestibular Migraine (VM) patients and normal healthy subjects. All patients were consecutive patients who presented to the Otolaryngology clinic at Ramathibodi Hospital during January 2009 – December 2015. MD patients were diagnosed using the criteria established by the AAO HNS, Balance and Hearing Committee, 1995 [1]. VM patients were diagnosed according to the criteria suggested by Neuhauser et al. [24].

The normal healthy control subjects were volunteer adults whom had been tested in the previous report [25]. All subjects received a detailed history taking and local checkup of ear, nose, and throat fields, followed by a routine audiometry, tympanometry and cVEMP test as described elsewhere [25].

Data analysis

SPSS package 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 measurement of cVEMP response was considered "abnormal" included the absent of response and the abnormal Asymmetry Ratio (AR). The 35% cut-off was used as the upper limit of normal response in Thai subjects [25]. The percentages of abnormal cVEMP response in all groups were compared using Chi-square test. The sensitivity and specificity of the cVEMP results in the MD group and the VM group were investigated.

Table 4: Percentage of abnormal cVEMP results in MD, and control groups.

VEMP results	**Disease status**				X^2	*p-value*
	MD		Control			
	n	%	n	%		
Abnormal VEMP	42	62.68	1	3.12	31.271	0.000
Normal VEMP	25	37.32	31	96.88		
Total	67	100	32	100		

Table 5: Percentage of abnormal cVEMP results in VM and control groups.

VEMP results	**Disease status**				X^2	*p-value*
	VM		Control			
	n	%	n	%		
Abnormal VEMP	11	19.64	1	3.12	4.718	0.030
Normal VEMP	45	80.36	31	96.88		
Total	56	100	32	100		

Results

In the MD group, there were 22 males and 45 females (67.17%) having mean age of 50.62±9.41 years and mean PTA in the affected ears (Rt. ear=37, Lt. ear=30) of 45.95±22.58 dBHL. In the VM group, there were 5 males and 51 females (91.07%) having 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. In control group, there were 13 males and 19 females (59.37%) having mean aged of 45.47±9.54 years and mean PTA of 16.02±6.28 dBHL. No significant difference in age was found among all groups ($p > 0.05$). However, predominant female subjects were found in VM group. PTA hearing threshold of MD was higher than both VM and control subjects but no significant different between VM and control groups (Table 1).

In the MD group, testing of cVEMP revealed abnormal responses in 42 out of 67 cases showing the percentage of 62.68%. In the VM group, testing of cVEMP revealed abnormal responses in 11 out of 56 cases showing the percentage of 19.64%. While in the control group showed abnormal cVEMP response in one subject (3.12%). The Chi-square test of cVEMP and disease status percentages showed significant different at $p< 0.05$ (Table 2). The Chi-square test of these percentages showed significant difference between MD vs. VM (X^2-value 23.097, p=0.000) (Table 3), between MD vs. control (X^2-value 31.271, p=0.000) (Table 4), and between VM vs. control (X^2-value 4.718, p=0.03) (Table 5).

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

Discussion

The cVEMP test was proved to detect saccular dysfunction and many studies tried to explore abnormalities of VEMP findings in MD and VM [16-24,26-35]. From Table 2, the percentage of abnormal cVEMP responses found in the MD group (62.68%) was significantly higher than those found in the VM (19.64%) and the control groups (3.12%). ($p< 0.001$) The sensitivity of cVEMP for detection of MD patient was higher than for the VM patient (62.68 vs. 19.64) while the specificity of both groups was the same (96.88 vs. 96.88). This should be suggested that the saccular involvement was more commonly occur in the MD than the VM patients. This finding was similar to Egami

et al. [26] study in 114 MD that cVEMP could provide appropriate diagnosis in 50% of MD cases but giving 48.9% specificity comparing to other vestibular disorders. In the VM group, they reported higher percentage of abnormal cVEMP than our study (29.3%). Absent or augmented cVEMP amplitude on affected ear was found in 54% up to 71% of MD patients [17,27,28]. On the other hand, cohort study from Mexico found similar reduction of cVEMP amplitudes in both MD (n=20) and VM (n=21) groups [29].

Various authors have investigated the cVEMP in MD and taken a wide range of parameters into consideration [16-23,30-32]. Rauch et al. [20] studied VEMP recordings from 14 normal individuals compared to those from 34 MD subjects and found significant difference in cVEMP amplitudes between normal ears, unaffected MD ears and affected ears. With low frequency tone bursts, cVEMP was presented in all normal subjects but only 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 scoring correctly by 250 Hz. cVEMP was 80% and for click cVEMP was 55% [23]. Taylor et al. [32] 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 differentiation between MD and VM.

Difference in percentage of abnormal cVEMP results in MD might be from different in protocol of study using TB of 500 Hz showed less sensitivity to 1000 Hz. (resonance frequency tuning shift) [33] and also number of subjects and varying in disease staging. However, when the test is abnormal, then 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 detecting of horizontal semicircular canal function. The sensitivity of ECochG was about 60-65% using ear tip-trode [3-6], a caloric test was about 48-74% using 25-30% interaural different criterion [7,8,10], and dehydrating agent 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), the cVEMP was easier to perform, less uncomfortable and well tolerated by the patients. In addition, the cVEMP test had no risk of hypotension, dizziness, nausea, vomiting or muscle weakness in contrast to dehydrating agents or a caloric test. From clinical observations, the ECochG took more time to operate than the cVEMP in the same cases. Moreover, it could be performed on patients with severe to profound hearing loss in which the ECochG was confounded because of its limitation. Hence, the cVEMP should be included as one of the audio-vestibular test battery for MD or other vestibular disorders suspected of the saccular portion involvement.

Controversy found in cVEMP investigation in MD as the percentage of abnormal cVEMP should be greater in more advance stage of the disease [26,31,34,35]. Moreover, saccular involvement showed to have a greater chance of having poor hearing outcome [35]. More important in identifying abnormal cVEMP on unaffected ear (35%) should be alert a physician of subclinical hydrops on the good ear [36]. Nevertheless, more researches need to be performed in this field for better management of the patients.

This present study suggested that the cVEMP showed fairly effect for a screening tool due to a slightly low sensitivity (62.68%) depending on disease staging, but could be used for identifying saccular involvement in a case of definite MD because of its high specificity (96.88%). The results also suggested that cVEMP should be used as a confirmative test or for staging of the disease progression or either in differentiation between MD vs. VM patients, rather than a screening test for detection of hydrops.

Conclusion

The cVEMP testing is a new way of assessing the saccular function in MD. The sensitivity and specificity of cVEMP in unilateral definite MD were 62.68%, and 96.88%, respectively. The sensitivity of cVEMP in MD group was significantly higher than in VM (19.64%) and the control groups (3.12%). These findings suggested more saccular involvement in the MD than the VM patients. This study revealed that the sensitivity of VEMP was not superior to ECochG, caloric and dehydrating tests. Thus, the cVEMP should be used as a confirmative test or for staging of the disease progression or either in differentiation between MD vs. VM patients, rather than a screening test for detection of hydrops.

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