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ORIGINAL ARTICLE

Clinical Significance of Vestibular Function with Caloric and Vestibular Evoked Myogenic Potential Testing for Patients with Simple Chronic Otitis Media

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Objective: To evaluate the results of preoperative vestibular testing for patients with COM, to find correlation between the results of vestibular testing and the symptoms of dizziness/vertigo.

Materials and Methods: Thirty-seven patients with conductive hearing loss due to unilateral COM without cholesteatoma, who prepared to undergo tympanoplasty surgery, participated in this study between December 1, 2007 and February 28, 2009. The outcome measures included history of dizziness/vertigo, vestibular function test abnormalities defined by air caloric weakness, abnormal latency and amplitude on VEMP test.

Results: Twenty-two (59.5%) of the total 37 patients had a history of dizziness/vertigo. The abnormal results of caloric test and VEMP test were for 20 (54.1%) of the patients and for 27 (73%) of the patients, respectively. Thirty patients (81.1%) had either abnormal caloric test or abnormal VEMP test results, on the other hand, seven patients (18.9%) had normal results in both tests.

Conclusion: A high incidence rate (81.1%) of abnormality was observed on the results of either air caloric test or vestibular evoked myogenic potential (VEMP) test for patients with unilateral simple chronic otitis media (COM). It is suggested that documentation of preoperative vestibular function for patients with simple COM could have significant legal connotations.

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Introduction

Patients with chronic otitis media (COM) often have a history of dizziness or vertigo. The correlation between dizziness and vestibular function testing was seldom reported in the medical literature due to some problems of technical difficulty and anatomic asymmetry [1-4]. There are various methods available for evaluating the vestibular function such as caloric test, rotational chair test, and vestibular evoked myogenic potential (VEMP) test. The toxins secreted by patients with COM could induce dizziness/vertigo, tinnitus, and sensorineural hearing loss through round window and oval window [5, 6]. The caloric test and VEMP test were designed to evaluate the vestibular functions of superior vestibular nerve and inferior vestibular nerve[3,7].

It is difficult to perform open-loop water caloric test for patients with COM technically and also due to contraindication to the fear of infection. However, Gianoli reported that the results of closed-loop air caloric test were correlated well with abnormalities by rotational test for patients with COM [2]. Sometimes the

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accuracy of tone burst VEMP test could be doubted due to the status of conductive hearing loss. The combination of bone-conducted VEMP and tone burst VEMP tests showed high specificity for the symptoms of dizziness/vertigo of patient with COM [1, 8].

The purpose of this study was to evaluate the results of preoperative vestibular function testing for patients with simple COM by air caloric test and tone burst/tapping forehead vestibular evoked myogenic potential (VEMP) test. The correlation between the results of vestibular function testing and the symptoms of dizziness/vertigo will be examined and their significances will be investigated.

Materials and Methods

This study included the patients who were diagnosed with simple COM unilaterally and received underlay tympanoplasty at the Otolaryngology Department of Kaohsiung Medical University Hospital in Taiwan between December 2007 and February 2009. The patients with cholesteatoma, revision surgery, diabetes, cardiovascular diseases, neurological diseases, and malignancy were excluded in this study. All the candidate patients received a detailed medical history taking and a battery of tests including physical-neurological examination, otoscopic examination, air caloric test, and VEMP test.

Identification of Air caloric test

The caloric test was performed using a bithermal method (24˚C and 50˚C air) with electronystagmographic recordings (SYNAPSYS, VNG VLMER). The unilateral weakness represents the percentage of difference of the maximum slow-phase velocity between lesioned and healthy labyrinthine response divided by the sum of the maximum slow-phase velocity in both ears. In this study the normal limit of the caloric response is within 20% of the unilateral weakness.

Identification of VEMP test

VEMP test was displayed by way of unilateral sternocleidomastoid muscle as the target for recording. The surface electromyographic activity was recorded ipsilaterally (Grason-StadIer, Audera Ver 2.1), while the patient was instructed to keep lateral head-turning absolutely in sitting position. The other reference and ground electrodes were separately set on the suprasternal notch and forehead. The short tone burst (95 dBHL, 500 Hz, 5 times/second, 200 times/stimuli) was conducted to the unilateral ear through an insertion-type earphone. Following the VEMP test by tone burst stimulation, every patient underwent the tapping method [1]. The forehead of patient was tapped by tendon hammer (5 times/second, 200 times/stimuli) to elicit response through bone-conduction stimulation, just like tone burst stimulation during the process of the recording, the instructor observed the monitor and the patient concentrated.

Thirty healthy persons without any ear problems were run the VEMP test by tone burst method. The comparison between VEMP test results of patients with COM and those of healthy persons were carried out to establish the baseline information.

The serial appearances of wave p13 and n23 were measured to determine the result of the VEMP response. The abnormality of VEMP test results were judged on the basis of the amplitude of p13-n23 or the latencies of p13 and n23 (Figure 1).

Results

A total of 37 patients including 13 males (35%) and 24 females (65%) with unilateral simple COM, aged from 14 to 76 years with an average of 48.2 years, participated in this study. Of the 37 patients, 20 cases were on the right ear and 17 were on the left ear. Twenty-two (59.5%) of the 37 patients had a history of dizziness/vertigo. Thirty (81.1%) of the 37 patients had abnormal results on caloric test or VEMP test. Twenty patients (54.1%) had abnormal caloric test results and twenty-seven patients (73.0%) had abnormal VEMP test results. Only 7 patients (18.9%) showed normal vestibular results with caloric test and VEMP test (Table 1). There was no difference between caloric test and VEMP test among all the 37 patients with unilateral COM (Table 2).

The correlation between the symptoms of dizziness / vertigo and the prediction for caloric test results were shown in Table 3. The accuracy rate was 51.4%, and the positive predictive rate was 60.0%. The correlation between the symptoms of dizziness / vertigo and the prediction for VEMP test results were shown in Table 4. The accuracy rate was 43.2%, and the positive

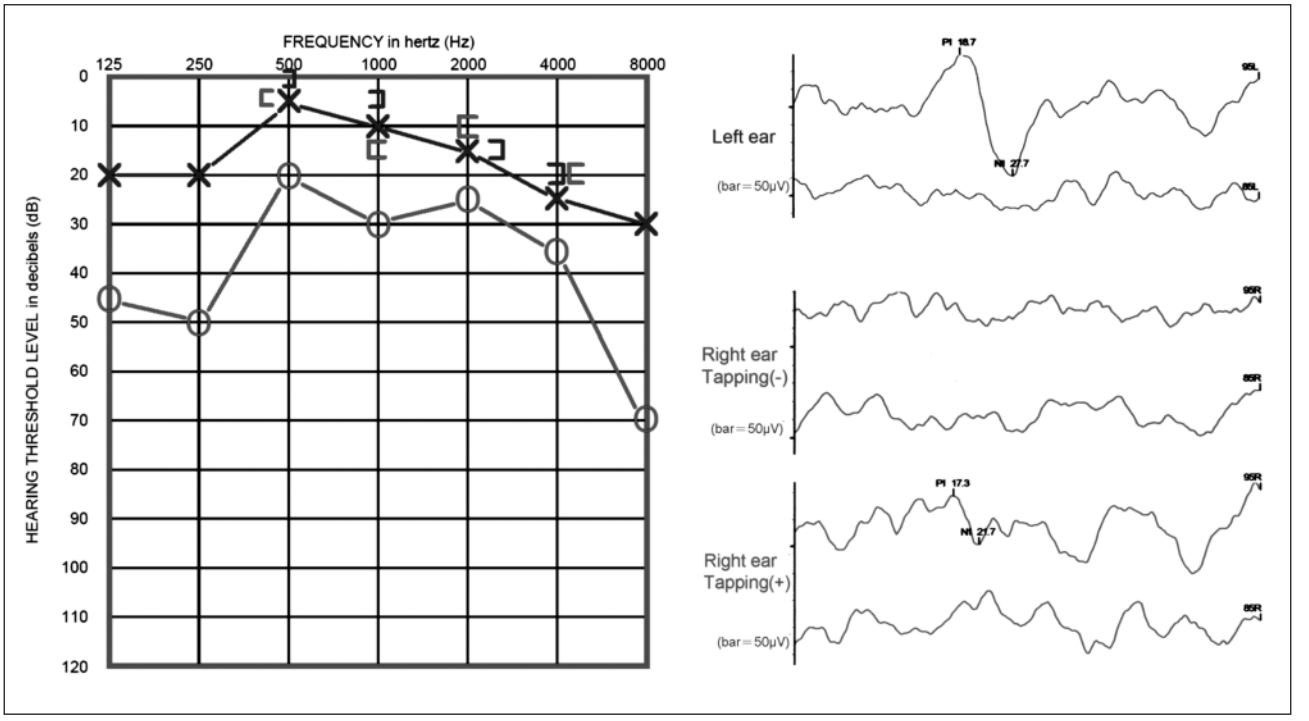

Figure 1. (Left).49-year-old male with Right COM with dizziness. Audiometry reveals conductive hearing loss in the right ear. VEMPs can be evoked in the left ear by the tone burst (Right, Upper). VEMPs can not be evoked in the right ear by the tone burst (Right, Middle),it can be evoked only by the tapping method and reveals depressed amplitude of p13-n23 (Right, Lower). bar=50μV.

Table 1. Correlation between clinical symptoms of dizziness/vertigo and Caloric & VEMP tests for 37 patients with unilateral simple COM

Test	Dizziness / Vertigo (+)	Dizziness / Vertigo (-)	Total
	22 (59.5%)	15 (40.5%)	37 (100%)
Abnormal Caloric test	12 (32.5%)	8 (22.2%)	20 (54.1%)
Abnormal VEMP test	14 (37.9%)	13 (40.7%)	27 (73.0%)
Abnormal Caloric test or VEMP test	16 (43.2%)	14 (40.7%)	30 (81.1%)
Abnormal Caloric test and VEMP test	10 (27.0%)	7 (22.2%)	17 (45.9%)
Normal Caloric test and VEMP test	6 (16.2%)	1 (2.7%)	7 (18.9%)

Table 2. Results of Caloric test and VEMP test for 37 patients with unilateral simple COM

		Caloric test		
		Normal	**Abnormal**	**Total**
VEMP	Normal	7 (18.9%)	3 (8.1%)	10 (27.0%)
	Abnormal	10 (27.0%)	17 (46.0%)	27 (73.0%)
	Total	17 (45.9%)	20 (54.1%)	37 (100%)

No significant correlation between Caloric test and VEMP test results
Fisher's exact test, P>0.05

Table 3. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the symptoms of dizziness / vertigo for the prediction of caloric test results by 37 patients with unilateral simple COM

	Caloric test		
Symptoms	**Abnormal**	**Normal**	**Total**
Dizziness / Vertigo (+)	12 (32.5%)	10 (27.0%)	22 (59.5%)
Dizziness / Vertigo (-)	8 (21.6%)	7 (18.9%)	15 (40.5%)
Total	20 (54.1%)	17 (45.9%)	37 (100%)

Accuracy: 51.4%; PPV: 60.0%; Sensitivity: 54.5%; NPV: 41.2%; Specificity: 46.7%

Table 4. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the symptoms of dizziness / vertigo for the prediction of VEMP test results by 37 patients with unilateral simple COM

	VEMP test		
Symptoms	**Abnormal**	**Normal**	**Total**
Dizziness / Vertigo (+)	14 (37.9%)	8 (21.6%)	22 (59.5%)
Dizziness / Vertigo (-)	13 (35.1%)	2 (5.4%)	15 (40.5%)
Total	27 (73.0%)	10 (27.0%)	37 (100%)

Accuracy: 43.2%; PPV: 51.9%; Sensitivity: 63.6%; NPV: 20.0%; Specificity: 13.3%

predictive rate was 51.9%. Both the caloric test and VEMP test were categorized into vestibular function testing. The correlation between the symptoms of dizziness / vertigo and the prediction for vestibular function testing results were shown in Table 5. The accuracy rate was 45.9%, and the positive predictive rate was 53.3%.

Discussion

The symptoms of dizziness/vertigo usually occurred in patients with chronic otitis media. The vestibular systems including utricle, saccule, and semicircular canals were probably affected by chronic infection or inflammation [9, 10]. Although the limitations of anatomy and technology have been mentioned, some authors reported encouraging results of vestibular function testing in patients with middle ear diseases.

Early in 1979, Paparella et al. [3] reported air caloric test for otitis media. They described different caloric responses according to the conditions of otitis media and obtained the following conclusions: (1). Patients with a small tympanic membrane perforation of one ear may show a caloric response equal to that of an intact ear. (2). Patients with a large tympanic membrane perforation on one side may show hyperactive caloric responses on the perforated side. (3). Patients with a moist ear may show inverted horizontal nystagmus to warm air caloric test.

In 1998, Casselbrant et al. [10] reported that children with otitis media with effusion may be more visually dependent for balance than healthy age-matched controls by investigating the influence of optic flow on postural sway. They concluded that otitis media with effusion may affect vestibular function in children. In 2000, they presented the balance function in four-year–old children with past history of middle ear effusion by rotational and moving platform posturography tests [4]. They demonstrated significantly lower average gain to a rotational stimulus of 0.1 Hz, 150 degrees/s.

In 2008, Gianoli and Soileau [2] reported the correlation between caloric test and rotational chair test in patients with chronic suppurative otitis media. They concluded that the incidence of abnormalities on caloric test was high and correlated well with rotational chair test abnormalities (80% accuracy). They suggested the validation of air caloric test for evaluating vestibular function in patient with chronic otitis media.

Vestibular evoked myogenic potential (VEMP) test is a clinical tool for examining patients with vestibular disorders. The VEMP test is a biphasic response elicited by loud clicks or tone bursts recorded from the tonically contracted sternocleidomastoid muscle through sacculocollic to inferior vestibular nerve [1, 7, 11]. The VEMP response may be absent in the existence of conductive hearing loss, when air-bone gap is more than 20 dB [12]. In order to promote the response rate of VEMP test in patients with chronic otitis media, the stimulating sound may be replaced by tapping evocation. In 2003, Yang and Young [1] concluded that myogenic potentials may be evoked with the tapping method to elicit the absent VEMP responses from middle ear or inner ear pathology.

In this study, the inner ear balance or vestibular functions were evaluated with the applications of air caloric test and VEMP test. The caloric test can indicate the function of lateral/superior semicircular canal, and superior vestibular nerve [7]. On the other hand, the VEMP testing may reveal the function of saccule, posterior semicircular canal, and inferior vestibular nerve [7]. We postulated that the possible causes of vestibular dysfunction in patients with COM might originate from either superior vestibular or inferior vestibular system.

In this study, an incidence rate of 59.5% in patients with unilateral simple COM had complaints of dizziness/vertigo. There was a higher incidence rate of abnormal results in either air caloric test or VEMP test (81.1%) for the same patient group. The present study demonstrated that most patients with COM suffered from vestibular abnormalities through vestibular function tests; however, it seemed no significant correlation between the results of vestibular function tests and the symptoms of dizziness/vertigo. It was suspected that the mechnism of central compensation occurred due to chronic process of otitis media. In consquence, patients with COM would not suffer from an episode of dizziness/vertigo despite the abnormal vestibular function test results.

There was not a significant relationship between the results of caloric test and VEMP test (Table 2). Because the caloric test and the VEMP test were applied to evaluate different locations of the vestibular systems, the correlation might not be high. The results of different vestibular tests help identify the origins of dizziness/vertigo. It could assist clinical doctors in the documentation of preoperative vestibular function in patients with COM [2].

The clinical symptoms of dizziness/vertigo had an accuracy rate of 51.4% for predicting caloric test results, an accuracy rate of 43.2% for predicting VEMP test results, and an accuracy rate of 45.9% for predicting either caloric test or VEMP test results. In addition to technical difficulty and anatomical asymmetry, the accuracy rates were not high because the sample size was not large. The confounding bias was one of the drawbacks in this study. In order to eliminate the effects of other diseases, samples were excluded for the patients with a history of revised surgery or cholesteatoma. Clinically the true cause of dizziness/vertigo in patients with COM was not fully understood. We focused the study on a single and uncomplicated disease.

Preoperative information of vestibular function could be provided to patients with COM by corroborations of vestibular function tests either air caloric test or VEMP

Table 5. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the symptoms of dizziness / vertigo for the prediction of caloric test or VEMP test results by 37 patients with unilateral simple COM

	Either Caloric test or VEMP test		
Symptoms	**Abnormal**	**Normal**	**Total**
Dizziness / Vertigo (+)	16 (43.2%)	6 (16.2%)	22 (59.5%)
Dizziness / Vertigo (-)	14 (37.9%)	1 (2.7%)	15 (40.5%)
Total	30 (81.1%)	7 (18.9%)	37 (100%)

Accuracy: 45.9%; PPV: 53.3%; Sensitivity: 72.7%; NPV: 14.3%; Specificity: 6.7%

test. It would be helpful for doctors to explain the vestibular function to patients with COM and also helpful for surgeons to keep away from medical disputes by accurate documentation.

Conclusion

A high incidence rate (81.1%) of abnormality was shown by vestibular function results of either caloric test or VEMP test for patients with unilateral simple COM. It is suggested that the integrated documentation of vestibular function in patient with COM preoperatively. This could be a significant legal connotation for preventing medical disputes between doctors and patients.

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