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Do patients who experience episodic tilting or translational sensations in the pitch plane have abnormal sacculo-collic reflexes?

Toshihisa Murofushi*, Sakurako Komiyama, Eriko Yoshimura

Department of Otolaryngology, Teikyo University School of Medicine, Mizonokuchi Hospital, 3-8-3 Mizonokuchi, Takatsu-ku, Kawasaki 213-8507, Japan

HIGHLIGHTS

- Patients who experience episodic tilting or translational sensations in the pitch plane were assessed using cVEMP and oVEMP testing.
- These patients often exhibited abnormal cVEMP.
- Such patients can be categorized as having "idiopathic saccular dysfunction".

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ABSTRACT

The otolith-collic and otolith-ocular reflexes of patients who experienced episodic tilting or translational sensations in the pitch plane without any other vestibular symptoms were assessed using cervical vestibular evoked myogenic potentials (cVEMP) and ocular vestibular evoked myogenic potentials (oVEMP). Eleven patients (4 men and 7 women, mean age = 40.4) were enrolled. All of the patients complained of episodic tilting or translational sensations in the pitch plane. Patients with a medical history of rotatory vertigo, loss of consciousness, head trauma, or symptoms of central nervous dysfunction or proprioceptive dysfunction and those who had been definitely diagnosed with a disease that causes disequilibrium were excluded. All 11 patients underwent cVEMP and caloric tests. Ten patients participated in the oVEMP tests. Seven of the 11 patients exhibited unilateral cVEMP absences, two displayed bilateral cVEMP absences, one demonstrated unilaterally decreased cVEMP, and one displayed normal cVEMP. Concerning oVEMP, 2 of the 10 patients showed unilateral oVEMP absences, 2 displayed bilateral oVEMP absences, 2 exhibited unilaterally decreased oVEMP, and 4 displayed normal oVEMP. All patients exhibited normal bilateral caloric responses. These findings were distinct from the results obtained for patients who experienced episodic lateral tilting sensations in previous studies. While most of the latter patients exhibited abnormal oVEMP, the patients in the present study tended to display abnormal cVEMP. These results suggest that patients with episodic tilting or translational sensations in the pitch plane suffer from saccular dysfunction. We propose "idiopathic otolithic vertigo" as a clinical entity and suggest that it is caused by idiopathic saccular dysfunction and/or utricular dysfunction.

1. Introduction

The otolith organs, the utricle and saccule, act as sensors of linear acceleration [8]. From the viewpoint of polarity, the saccular macula seems to be sensitive to tilting and translation in the pitch plane while the utricular macula seems to be sensitive to lateral tilting [6]. Recently, we reported that patients who experienced episodic lateral tilt sensations without any other vestibular symptoms displayed abnormal ocular vestibular evoked myogenic potentials (oVEMP), while their cervical vestibular evoked myogenic potentials (cVEMP) remained normal [13]. As oVEMP testing seems to predominantly reflect the utriculo-ocular reflex [5,12] and cVEMP seems to predominantly reflect the sacculo-collic reflex [4,11], in our previous study we concluded that patients that exhibit episodic lateral tilt sensations without any other vestibular symptoms are suffering from utricular dysfunction, but often retain their saccular function, and proposed that these patients should be diagnosed with "idiopathic otolithic vertigo", especially "idiopathic utricular vertigo" [13].

Accordingly, we hypothesized that patients that experience episodic tilting or translational sensations in the pitch plane might

* Corresponding author. Tel.: +81 44 844 3333; fax: +81 44 813 2257.
E-mail addresses: toshi-tky@umin.ac.jp, murofush@med.teikyo-u.ac.jp (T. Murofushi).

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display abnormal cVEMP but normal oVEMP due to saccular dysfunction. To verify this hypothesis, we recorded cVEMP and oVEMP in such patients.

2. Materials and methods

2.1. Patients

Among patients that presented with balance problems at our clinic, those who fulfilled the criteria described below were enrolled in this study.

2.1.1. Inclusion criterion

The subjects had to have experienced episodic tilting or translational sensations in the pitch plane.

2.1.2. Exclusion criteria

Subjects with any of the following were excluded:

1. A medical history of rotatory vertigo.
2. A medical history of loss of consciousness or severe head trauma.
3. Symptoms of central nervous system dysfunction or proprioceptive dysfunction.
4. A definitive diagnosis of a disease known to cause disequilibrium (e.g., Meniere's disease, vestibular migraine).

2.2. Methods

Patients who fulfilled the abovementioned criteria underwent tests including assessments of their cVEMP and oVEMP and caloric tests. The methods used to record the oVEMP and cVEMP were described elsewhere [12]. Here, we describe the methods in brief. The Neuropack system (Nihon Kohden Co. Ltd., Japan) was used to record both cVEMP and oVEMP.

2.2.1. cVEMP

To record cVEMP, electrodes were placed on the upper half of each sternocleidomastoid muscle (SCM), with a reference electrode placed on the lateral end of the upper sternum and a ground electrode placed on the nasion. During the recording, the subjects were instructed to lie in the supine position and raise their heads to contract the SCM. As acoustic stimuli, air-conducted 500 Hz short tone bursts (125dBSPL, rise/fall time = 1 ms, plateau time = 2 ms) were delivered through headphones (Type DR-531, Elega Acous. Co. Ltd., Japan) at a stimulation rate of 5 Hz. The signals were amplified and bandpass-filtered (20–2000 Hz), and 100 responses were averaged. The time window for the recording ran from −20 ms to 80 ms. To confirm the reproducibility of the results, 2 runs were performed for each ear. The responses produced by the SCM ipsilateral to the stimulated ear were assessed. Specifically, we analyzed the first biphasic responses (p13-n23) [4]. In order to eliminate the effect of variations in muscle activity, the mean background amplitude was calculated from the mean rectified background activity during the 20 ms pre-stimulus period. The corrected amplitude (CA) of the cVEMP was defined using the following ratio in each run: amplitude of (p13-n23)/mean background amplitude. The corrected cVEMP amplitude (dimensionless) was employed for interaural comparisons. For these comparisons, the percentage cVEMP asymmetry was calculated as follows:

Percentage cVEMP asymmetry = 100 |CAcr−CAcl|/(CAcr+CAcl)
CAcr(l) = corrected amplitude of p13-n23 on the right (left)
|CAcr−CAcl| = the absolute value of CAcr−CAcl.

According to a previous study recorded under the same conditions [12], the upper limit of the normal range of percentage cVEMP asymmetry was defined as 41.6.

2.2.2. oVEMP

The recording electrodes were placed just beneath the lower eyelids (active) and 2 cm below the active electrodes (indifferent) with the ground electrode placed on the nasion. The same stimuli as were used to record the cVEMP were employed as acoustic stimuli. The subjects were asked to maintain an upward gaze during recording. The responses produced under the eye contralateral to the stimulated ear were assessed. Specifically, we analyzed the first biphasic responses (NI-PI) [3]. The other aspects of the recording method were the same as those used to record cVEMP.

The corrected oVEMP amplitude (dimensionless) was employed for interaural comparisons.

Percentage oVEMP asymmetry = 100 |CAor−CAol|/(CAor+CAol)
CAor(l) = corrected amplitude of NI–PI on the right (left) side
|CAor−CAol| = the absolute value of CAor−CAol.

According to a previous study recorded under the same conditions [12], the upper limit of the normal range of percentage oVEMP asymmetry was defined as 44.3.

2.2.3. Caloric tests

Caloric tests were performed in a dark room using electronystagmography (ENG) by irrigating the external ear canal with cold water. In the caloric test, canal paresis (CP) was calculated using the maximum slow phase eye velocity of caloric nystagmus.

Informed consent was obtained from all subjects, and ethical approval was received from the Ethics Committee of Teikyo University.

3. Results

3.1. Patients' profiles

Eleven patients (4 males and 7 females) fulfilled the inclusion and exclusion criteria (Table 1). Their ages ranged from 33 to 65 (mean: 40.4). The duration of each episode ranged from 1 min to one day. The majority of patients stated that their attacks lasted for a few minutes to 30 min. However, some patients had longer attacks.

3.2. cVEMP

Among the 11 patients, 7 patients did not display a cVEMP response on one side (right:left = 1:6) (Fig. 1). In addition, 2 patients did not display cVEMP on either side, one patient exhibited decreased cVEMP amplitudes on one side (the left side), and one showed bilateral normal responses.

3.3. oVEMP

Among the 10 patients who underwent oVEMP testing, 2 patients did not display oVEMP responses on one side (right:left = 1:1). Note that in the cases involving the unilateral absence of both oVEMP and cVEMP, both effects were always detected in the same ear. In addition, 2 patients did not display oVEMP responses on either side, 2 demonstrated decreased amplitudes on one side (right:left = 1:1), and 4 showed bilateral normal responses.