Vestibular evoked myogenic potential for diagnoses of multiple sclerosis: Is it beneficial?

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ABSTRACT

Aim To determine the sensitivity of the vestibular evoked myogenic potential (VEMP) in multiple sclerosis (MS) patients as well as its relation to clinical signs and symptoms, course of the disease and other evoked potentials.

Methods This case-control study was conducted on 40 subjects (20 MS patients and 20 healthy participants). Participants were selected from Imam Khomeini Hospital, Tehran, Iran. Two hundred stimuli (clicks of 0.1 ms of duration and 2 Hz frequency) were applied to each ear. These stimuli were repeated in two consecutive cycles. In order to evaluate the reproducibility the stimulation intensity of 95dBNHL was applied. During the test, individuals were requested to be seated on a chair and rotate their head to the opposite side of the stimulated ear to activate the ipsilateral sternocleidomastoid muscle (SCM).

Results A biphasic, initially positive, p13-n23 wave pattern was found in all patients. All of the parameters, including latencies and amplitudes fit the normal Kolmogorov-Smirnov (KS) distribution. Fourteen (70%) patients reported abnormal results, and VEMP abnormality was significantly related to disease duration also. In addition, there was a significant correlation between abnormality of VEMP and abnormality of visual evoked potential (VEP) as well as the abnormality of VEMP and brainstorm auditory evoked potential (BAEP).

Conclusion Vestibular evoked myogenic potential has a high sensitivity (70%) in MS patients, and VEMP could be recommended as a useful complementary neurophysiological method to evaluate the MS patients.

Keywords: sensitivity, course of disease, vestibular, evoked potentials
INTRODUCTION

Acoustic energy enters the labyrinth through middle ear and activates saccular hair cells (1). Impulses reach the inferior vestibular nerve and then enter the lateral vestibular nucleus; and finally reach the motor neurons of the neck muscles via a medial vestibulospinal pathway (2) and result in short latency inhibitory potential in the contracted ipsilateral SCM muscle (3). This response is called “vestibular evoked myogenic potential” (VEMP).

Ford et al. originally described the characteristics of recorded short latency potentials from posterior neck muscles, with an active electrode placed just below the inion, after click stimulation. They concluded that such responses are myogenic in origin and arise from activation of the vestibular system rather than activation of the cochlea (4). This potential has vestibular origins, because this response was presented in patients with cochlear impairment and was absent in selective when block of vestibular nerve was done (5). Subsequent studies provided evidence, which showed that such responses depended on the activation of the otoliths, specifically in the saccule. In recent years, researchers showed that high-intensity clicks (95-100dB NHL) evoke a response in the active ipsilateral sternocleidomastoid muscle. This response composed of short latency, biphasic (P13/N23) wave, whose first part is positive (6).

Vestibular function evaluation plays a significant role in neurological examination. Conventional tests were used in electronystagmography, which could assess semi-circular canals and superior vestibular nerve only. In fact, VEMP recording enables the clinician to diagnose disorders in the saccule, vestibular nerve, inferior brain stem and vestibulospinal pathway (7-8). VEMP has already been used in evaluating peripheral vestibular pathologies, such as Meniere’s disease, vestibular neuritis and acoustic neuromas clinically also (9-12). On the other hand, there is a lack of awareness for the potential application of VEMP in diagnosing different brainstem pathologies, such as multiple sclerosis (MS). MS is a chronic inflammatory demyelinating disease of central nervous system (CNS) affecting more than one million people throughout the world (13). It is diagnosed by MacDonald’s criterion, which is based on clinical signs and symptoms, magnetic resonance imaging, lumbar puncture, and evoked potentials (14,15). Evoked potentials play an important role in MS diagnosis due to their ability to detect subclinical lesions (3), while VEMP is one of these evoked potentials. Although this test is a useful and noninvasive method to examine the function of vestibular nerve and inferior brain stem, there are fewer studies evaluated its importance in MS (16,17).

The aim of present study was to perform VEMP in the MS patients and examine any relevance between VEMP, MS course, and other evoked potentials.

METHODS

This case-control study was performed on 20 healthy volunteers (10 males and 10 females; age range: 19-41 years, mean age: 29.15±4.7years) and 20 patients who diagnosed as MS patients by the physician (10 males and 10 females; age range: 20-40 years; mean age: 30±5.4 years). Participants were selected from the Iran Center of Neurological Research in Emam Khomeini Hospital, which is the main neurological research center for MS in Iran.

Inclusion criteria were clinically definite multiple sclerosis of either relapsing remitting (RR) or secondary progressive (SP) type, according to McDonald’s criteria (14,15), lack of any hearing loss or disorders of the middle and external auditory system. Exclusion criteria were a limitation of neck rotation, weakness of sternocleidomastoid muscle, and consumption of vestibulo toxic or suppressant drugs within the past month. The VEMP, visual evoked potential (VEP) and brainstem auditory evoked potential (BAEP) were recorded for all the control and patients.

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The study protocol was approved by the Research Ethics Committee of Tehran University of Medical Sciences, and each patient completed an informed consent before participating in the study. Full history was taken, and then physical examination of all patients was performed. The of participants in the control group were healthy in terms of neurological aspects.

To perform VEMP and auditory stimulation, “Medelec Synergy” and headphones were used.
respectively. Individuals were requested to sit on a chair and rotate their head to the opposite side of the stimulated ear to activate the sternocleidomastoid muscle (SCM). After cleaning the skin, active surface electrode was placed on the upper half SCM of the stimulated side. Reference electrode and ground electrode were placed on the inner margin of ipsilateral clavicule and on the forehead, respectively. The electrodes were fixed in their place by electrolytic jelly and adhesive tape. Electrode impedance was less than 4KΩ.

The sound stimuli presented as rarefaction click of 0.1ms of duration and 2Hz frequency were applied. Two hundred stimuli were applied to each ear and repeated two times. The intensity of sound click was 95 dB NHL. Contralateral masking at 40 dB NHL was adopted. The band-pass filter of 10-1000 Hz was applied. Biphase initially positive-negative (P13-N23) reproducible waves were recorded. The responses to both series of sweeps were averaged to produce a mean for each ear and for each subject. Vestibular evoked myogenic potential was considered valuable, if two consecutive tests performed on the same ear verified the reproducibility.

The following parameters were recorded in pre-prepared record sheets: presence or absence of response, latency and amplitude of the first positive (P13) and first negative (N23) peaks, interpeak (P13-N23) latencies, peak to peak (P13-N23) amplitude, inter side latency difference, and interpeak amplitude difference.

The obtained VEMP recordings were evaluated and their relation to disease duration. Course of the disease, VEP, and BAEP were analyzed statistically.

The parameters evaluated in BAEP were latency of the 2nd, 3rd, 4th and 5th waves, amplitude of the 3rd and 5th waves, interpeak latency of 1-5, 3-5, 1-3 and interside differences of these parameters.

The parameters evaluated in VEP included p200 latency, amplitude difference.

In the healthy subject, all of above parameters were measured and fitted in the Kolmogorov-Smirnov (KS) distribution. VEMP was considered as abnormal when P13/N23 was absent or prolonged latencies <+2.5 SD on at least one side (3). T-independent and χ2 tests were used for the statistical analysis. P-value less than 0.05 were considered significant.

RESULTS

In the normal subjects, all of the VEMP parameters had KS distribution. The upper limits of normal latencies were 17.8 ms and 16.4 ms for P13 latency and 25.6 and 25.3 ms for N23 latency on the left and right, respectively (Figure 1). Table 1 shows latencies of VEMPs in both groups. Due to variability and wide dispersion of the amplitude in the control group, as in all evoked potential methods, normal limits of amplitude were not set up. Absent response (0 amplitude) in the patient group was considered as abnormal only. All MS patients had a biphase response.

![Figure 1. Vestibular evoked myogenic potential recorded on the left and right sternocleidomastoid muscle in response to clicks delivered on the left and on the right ear of a control subject (A) and a multiple sclerosis patient (B).](image)

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<tr>
<th>Table 1. Vestibular evoked myogenic potential latency measurements in control subjects and multiple sclerosis patients</th>
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<td>Control subjects</td>
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<td>MS patients</td>
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<td>Upper limits (Mean ±2.5 SD)</td>
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MS, multiple sclerosis; diff, difference
Fourteen out of 20 (70%) patients had abnormal VEMP; all of them were due to prolongation of latency parameters (Figure 2).

Thirteen out of 20 MS (65%) patients showed prolongation of P13 latencies (bilaterally in 8, unilaterally in 5 patients) or N23 latencies (bilaterally in 6 and unilaterally in 7 patients). Left inter-peak latency (P13-N23) was abnormal only in one patient. The inter side difference of P13 and N23 latencies were abnormal in three (15%) patients and four (20%) patients, respectively (p<0.01). Relapsing-remitting (RR) secondary progressive (SP) subtypes were seen in 14 (70%) and six (30%) patients, respectively. All SP subtypes of MS had abnormal VEMP; but it was abnormal only in eight out of 14 RR patients (57.1%) (p=0.07).

In abnormal VEMPs group (14 patients), the mean disease duration was 53.57 month (more than 4 years). However, in eight patients having normal VEMPs, the mean of disease duration was 17.83 month (p<0.01).

In our study, the sensitivity of BAEP and VEP were 65% and 75%, respectively. While in some other studies, these values were 39% and 67%, respectively (22). Vestibular evoked myogenic potential sensitivity in the present study was very close to the sensitivity of other evoked potentials; therefore, we may conclude that VEMPs could be used as a complementary diagnostic test in MS patients. In the present study, amplitudes of waves were normal, while in some other studies, less amplitude in MS patients was observed (3-20). However, in the study of Renata et al, amplitude was higher in patients than controls (23).

In VEMP, high-intensity sound click evoked inhibitory potential in the ipsilateral active SCM muscle (3). This potential has a vestibular origins, because it is present in patients with cochlear impairment, and is absent in selective section of vestibular nerve (7). Clinically, and neurophysiologically, it has been suggested that VEMP assesses saccule, vestibular afferent fibers, vestibular nuclei and vestibulospinal tracts ipsilaterally (18). In the present study, 70% of MS patients had some form of abnormality, which is similar to Alpini study (20). And the mean abnormality in our study was prolongation of P13 and N23 latencies in MS patients, which was in harmony with other studies (3-10). Vestibular evoked myogenic potential sensitivity included 70% in our study, 40% in Patko, 53% in Bandini, and 53.3% in Sartucci study (12, 19-21). Possible explanation for this variation of sensitivity could be the difference in the posture of patients. As in Alpini study, in our research, patients were in sitting position during the test. However, in Bandini and Patko studies, patients had supine position on the bed and were requested to raise their head off the bed to activate their neck muscles. Therefore, it could be suspected that the neck rotation in the sitting position will promote VEMP sensitivity; however, this subject remains to be elucidated.
and this can be used as a criterion for diagnosing VEMP abnormality.

Similar to other evoked potential’s modalities, VEMP is able to demonstrate subclinical dysfunction, as our patients with abnormal VEMPs were free of vertigo or other clinical signs of vestibular dysfunction during examination or their past history. In accordance with our study, 67% of patients in the study of Patkó et al, and 55% in the study done by Alpini et al, had no clinical signs in the presence of abnormal VEMP (3-20).

In addition, there was no statistically significant relation between a course of the disease and abnormal VEMP. The mean duration of the disease in our patients with abnormal VEMP was more than 4 years. Patkó et al. showed that in 75% of patients with abnormal VEMP, the duration of the disease was more than 10 years (3). This finding suggests that the chance of VEMP abnormality is higher in the more chronic cases.

In conclusion, VEMP test is objective, non-invasive and easy to perform, which may be considered as a complementary neurophysiological method for evaluating MS diagnosis; amplitude is not important criterion in VEMP abnormality, but increased latency, especially in P13 and N23, is valuable. It seems that we were not able to perform VEP and BAER in the some of the patients, e.g. blindness, severe nystagmus and sensory neural hearing loss. VEMP may be a good alternative test for VEP and BAER. Surely, these suggestions must be evaluated in further clinical studies with greater sample size.

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TRANSPARENCY DECLARATION

Competing interests: none declare

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