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Vestibular Evoked Myogenic Potentials in Multiple Sclerosis: A Comparison Between Onset and Definite Cases

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Abstract: Patients affected with multiple sclerosis (MS) frequently suffer from vestibular disorders due to vestibulospinal involvement. The vestibulospinal reflexes in these subjects can be well investigated through vestibular evoked myogenic potentials (VEMPs). Evoked by the acoustic stimulation of the saccular macula and mediated by the vestibulocollic reflex pathway, they are recorded using surface electromyographic electrodes from the ipsilateral sternocleidomastoid muscle tonically contracted. Abnormal findings (e.g., absence of response, prolonged latencies) disclose a lesion anywhere in the pathway. We examined VEMPs in 19 patients with definite MS (5 men, 14 women; age range, 31–59 years; mean age, 45 years) and compared them to VEMPs in 10 subjects with onset MS (2 men, 8 women; age range, 24–35 years; mean age, 29 years). VEMPs in definite MS subjects were abnormal in 14, absent (on the left side only) in 1, and normal in the remaining 4. In patients with onset MS, VEMPs were abnormal in 6. These results suggest that latencies of vestibulospinal reflexes can be remarkably delayed in MS at different stages of disease, whereas vestibulospinal involvement is more frequent in definite cases. To date, no study has yet investigated different VEMPs involvement at different stages of MS.

Key Words: multiple sclerosis; vestibular evoked myogenic potentials

Frequently, patients with definite multiple sclerosis (MS) are known to report symptoms related to vestibular disorders in the course of their illness. Vestibular symptoms (vertigo and dizziness) often occur at the onset of the disease. Many times, vestibulospinal reflexes are involved, and vestibular evoked myogenic potentials (VEMPs) are specific for documenting vestibulocollic involvement in MS patients [1].

VEMPs do not require any specific skill on the part of patients, and they may be investigated in all patients who are able to remain seated. They were described for the first time by Bickford et al. [2], who recorded short-latency potentials from an active electrode placed just below the inion in response to acoustic stimulation (the "inion response"). These authors revealed that the evoked response was probably generated by reflex changes in the electromyogram of posterior neck muscles and that it was present in patients with sensorineural deafness, leading the researchers to propose that it arose from the sound-evoked activation of the vestibular apparatus ("Tullio phenomenon") [3]. Subsequent publications by Cody and Bickford [4] described the inion response in subjects suffering from different cochlear and vestibular syndromes and provided further evidence to suggest that it depended on the activation of the saccular macula. Those authors concluded that VEMPs recording depended on the activation of a specific reflex function called the vestibulocollic reflex (VCR), mediated by a pathway consisting of the saccular macula, its primary neurons, vestibulospinal neurons from the lateral vestibular nucleus, the medial vestibulospinal tract and, finally, the motor neurons of the spinal cord reaching neck muscles [5].

Recent studies showed that rarefaction clicks are

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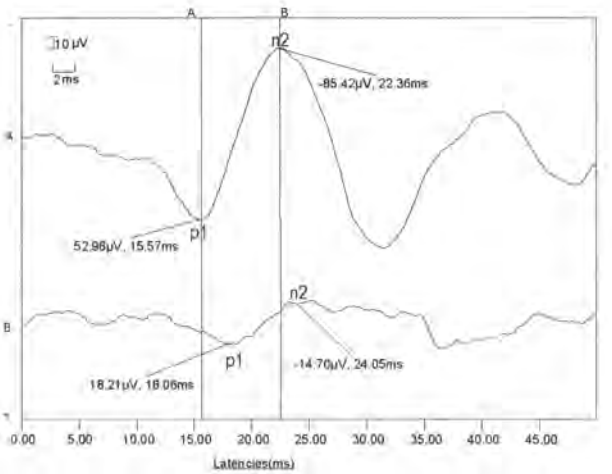

Figure 1. Normal (A) and pathological (B) vestibular evoked myogenic potentials. Normal morphology and latencies are seen on the left side (A), whereas increased latencies and decreased amplitude are seen on the right side (B).

preferred for evoking the saccular response and that the sternocleidomastoid muscle (SCM) is the most advisable recording site [6]. Healthy subjects produce a biphasic response from the SCM characterized by a positive peak at a latency of some 13 msec (P1) from the stimulus followed by a negative wave peaking some 10 msec later (N2; Fig. 1A) [7]. Abnormal results, ranging from prolonged latencies to total absence of the response, disclose lesions anywhere in the VCR pathway [8,9].

In MS patients whose disorders of balance could be caused by a progressive demyelination of vestibulospinal system nerve fibers, VEMPs recording represents a meaningful method to spot new lesions in the brainstem, to assess the extent of the vestibular damage, and to monitor the evolution of the disease [10–12]. To date, no study has yet investigated different VEMPs involvement at different stages of MS. The aim of our study was to compare VEMPs in subjects with onset and definite MS.

SUBJECTS AND METHODS

We recorded VEMPs from 29 patients enrolled from the Multiple Sclerosis Department of the Don Gnocchi Foundation, Milan, Italy. Of these, 19 were definite MS cases according to MacDonald's classification (5 men, 14 women; age range, 31–59 years; mean age, 45 years), and 10 were patients with onset MS (2 men, 8 women; age range, 24–35 years; mean age, 29 years).

The presence of external or middle-ear diseases that could interfere with the results had been ruled out in all subjects before the test. We requested that each patient be seated on a comfortable chair and keep the head rotated to the side opposite the stimulated ear to activate the SCM. We placed the active surface electromyogram electrode on the SCM of the stimulated side and referred it to the ipsilateral clavicle, whereas a ground electrode was fixed on the upper sternum.

The VCR was evoked by rarefaction clicks (duration, 100 msec; loudness, 95 dB normal hearing level; rate, 5 Hz) delivered by a pair of headphones in two series for a total of 200 sweeps. Contralateral narrowband masking (90 dB SPL) was adopted. We performed four repetitions on each side and made no adjustment for individual hearing loss. We presented a continuous noise of 70 dB to the contralateral ear and performed recordings using a standard clinical evoked potential averager (Nicolet CA2000, Clackamas, USA) with time bases of 50 msec. We also twice averaged the responses to both series of sweeps, to produce one grand average for each side and for each subject. The parameters evaluated were presence or absence of the response; latency of the first positive (P1) and negative (N2) peaks; interpeak latencies (P1–N2); and amplitudes measured peak to peak (P1–N2).

Because the amplitude of the response is influenced by the level of SCM contraction, which varies markedly between subjects, we mostly considered the latencies of the peaks, which are more stable and best suited to reflect the integrity of the vestibulospinal system pathway. Previously, we calculated the normal ranges in a normal population of 25 subjects (13 women, 12 men; mean age, 35.7 years). Normal values were 15.8 ± 1.5 msec for the P1 peak; 25.4 ± 1.8 msec for the N2 peak; and 9.8 ± 0.8 msec for the P1–N2 interpeak.

RESULTS

In definite MS patients, we found VEMPs to be abnormal in 14, absent (on the left side only) in 1, and normal in the remaining 4. In the onset cases, we found VEMPs to be abnormal in 6, presenting bilateral increase of latencies in 3 and having significant right-left asymmetry in the remaining 3 (Fig. 2). The interpeak latencies (P1–N2) always appeared within normal limits.

DISCUSSION

VEMPS recording undoubtedly represents a simple method to investigate vestibulospinal pathways integrity [13–15]. In fact, it provides rapid, useful information about vestibular and vestibulospinal reflex function. In addition, the test can be very important in MS patients, because they frequently suffer from equilibrium disorders related to vestibulospinal system involve-

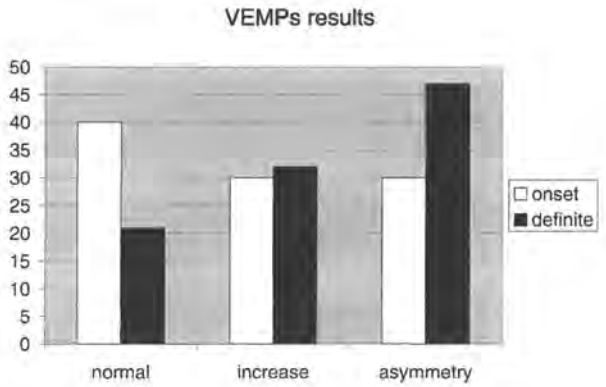

Figure 2. Results of vestibular evoked myogenic potentials (*VEMPs*) recordings comparing alterations in onset multiple sclerosis (MS) and definite MS patients. Prolonged latencies have been recorded in both groups; asymmetry of right-left responses is more frequent in definite MS cases. In the same way, in general, vestibular evoked myogenic potentials are more frequently compromised in definite cases than in onset cases.

ment. The main limitations of the test are lack of patient cooperation, presence of neck stiffness, inability of patients to keep the SCM tonically contracted for a few seconds, and the presence of external or middle-ear diseases (chronic otitis, otosclerosis). All these factors have a major influence on VEMPs amplitude.

Prolonged latencies have been recorded in both groups, whereas asymmetry of right-left responses is more frequent in definite MS cases. In the same way, in general, VEMPs are more frequently compromised in definite MS cases than in onset cases. Prolonged P1 or N2 latencies, abnormalities of the interpeak latencies, and a total absence of the response suggest the presence of lesions in the vestibulocollic pathway, probably arising from a progressive demyelination of the nerve fibers.

Previous studies [1,15–17] have shown good correlation in definite MS patients between VEMPs abnormalities and brainstem or cerebellar lesions; VEMPs were able to detect brainstem dysfunction in cases with normal nuclear magnetic resonance (NMR). In this group of onset MS cases, VEMPs were altered in 6 with normal NMR findings, and neuroimaging was altered in 2 with normal VEMPs. No study published to date has compared different stages of the disease.

Our study shows that in onset MS, VEMPs are less altered (60% vs. 80%) than in definite MS subjects. Latencies of vestibulospinal reflexes can be prolonged, and sometimes the response can be absent, depending on the degree of the nervous transmission dysfunction, a degree that seems to be correlated with the stage of disease. A delay of VEMPs can be attributed to demyelination either of primary afferent axons at the root entry zone or of secondary vestibulospinal tract axons, rather than to lesions of vestibular nucleus neurons.

Conversely, when demyelination of the vestibulospinal nerve fibers proceeds during the course of the disease, new lesions are produced. Prolonged peak latencies are also found in the early stages of the disease when other diseases mimicking MS must be ruled out [17]. VEMPs testing can thus be important also as a screening test.

On the basis of our experience, VEMPs recording may be considered a useful test for evaluating the function of the vestibulospinal pathways, both for detecting subclinical brainstem lesions in suspected MS patients and for monitoring the evolution of the disease.

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