

Effect of Body Posture on Vestibular Evoked Myogenic Potentials

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Abstract: VEMP recorded from surface electrodes over the tonically contracted sternocleidomastoid (SCM) muscle is a short latency biphasic electromyograms which evoked by high-level acoustic stimuli. Aim: To find the effect of posture and positioning on VEMP recording. Method: VEMP was recorded for 20 normal hearing subjects (18 to 20 years) with and no vestibular in both supine and sitting upright position with the head turned towards the contra lateral side of the stimulus. Results: Paired t test was used to compare the latencies of p1 and n1 in both positions. Statistical evaluation showed no significant difference in p1 (at t (19) =0.840, p>0.05) and n1 (at t (19) = 0.468, p>0.05) latencies in upright and supine position. Results of this study suggest that both supine as well as upright position can be used to record VEMP effectively.

Keywords: Vestibular Evoked Myogenic Potential (VEMP)

1. Introduction

Clinical tools for diagnosing vestibular disorders caused by semicircular canal dysfunction are more readily available than tests sensitive to otolith disorders. VEMP is relatively an innocuous and recent technique for assessing otolith function (Welgampola, and Colebatch 2005). It may supplement the current test battery by providing diagnostic information about saccular and/or inferior vestibular nerve function. The VEMPs are short latency biphasic electromyograms (EMG) that are evoked by high-level acoustic stimuli (click or tone burst) and are recorded from surface electrodes over the tonically contracted sternocleidomastoid (SCM) muscle.

VEMP is a vestibulo-collic reflex whose afferent limb arises from acoustically sensitive cells in the saccule, with signals conducted via the inferior vestibular nerve. Saccular generation conducted via the inferior vestibular nerve has been supported by a large number of human and animal studies. VEMP has been recorded from the sternocleidomastoid muscle, and studies using human subjects with well documented peripheral audiovestibular lesions have confirmed the vestibular origin of the response (Colebatch & Halmagyi, 1992). Colebatch and Halmagyi demonstrated that the VEMP is abolished following unilateral vestibular neurectomy. Thus VEMP testing may provide a useful and noninvasive method for assessment of otolith function and the functional integrity of the inferior vestibular nerve (Akin, Murnane, & Proffitt, 2003; Al-Abdulhadi, Zeitouni, Al-Sebeih, & Katsarkas, 2002)

2. Literature Survey

Studies have demonstrated poor correlation between VEMP and the degree of sensorineural hearing loss thus suggesting that VEMP is not mediated by the cochlear

afferents (Colebatch et al., 1994). Furthermore, the saccule has been implicated as the origin of the VEMP and a response pathway has been suggested from the vestibular saccule to the inferior vestibular nucleus, the lateral (Dieter's) nucleus, and the lateral vestibulospinal tract to the sternocleidomastoid (SCM) muscle where myogenic potentials are produced by the flexor neck motoneurons (Colebatch & Halmagyi, 1992). Thus the vestibular evoked myogenic potential (VEMP) is a promising test of the descending vestibulocollic system (Zapala, and Brey, 2004)

Characteristics of VEMP

Normal VEMP responses are characterized by biphasic (positive-negative) waves. The peaks and troughs are usually labeled with the mean latency in milliseconds preceded by the lowercase letters "p" (for positive) or "n" (for negative), as proposed by Yoshie and Okudaira (1969) to distinguish them from neurally generated evoked potentials. The first positive-negative complex is often labeled as p13-n23 or p1-n1 (see Figure 1).

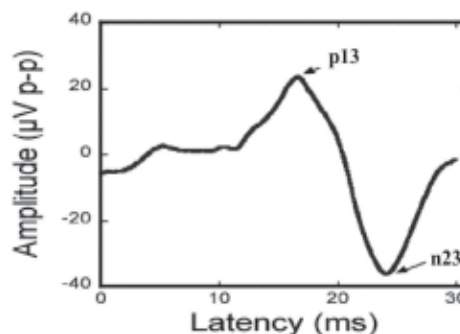


Figure 1: A representative VEMP wave form in a normal subject

There are variations in VEMP amplitudes, from a few microvolts to several hundred microvolts, depending on the muscle tension and intensity of the stimuli (Cheng & Murofushi, 2001a, 2001b; Colebatch, Halmagyi, & Skuse, 1994; Li et al., 1999; Ochi et al., 2001; Pyykko, Aalto, Gronfors, Starck, & Ishizaki, 1995; Versino, Colnaghi, Callieco, & Cosi, 2001; Wu & Murofushi, 1999; Wu, Young, & Murofushi, 1999). In contrast, the latency of the response is usually less varied and does not differ significantly from the right to left side.

3. Vestibulo-colic Reflex Pathway: (VEMP pathway)

When the cochlea is stimulated with intense sounds the sensory cells in the saccule also respond. The neural impulses travel up to the inferior division of the vestibular nerve (VIII CN), to the lateral vestibular nucleus, to the lateral vestibulospinal tract, to the accessory nerve (XI CN) and then to the sternocleidomastoid (SCM) muscle (Gans 2005). Diagnosis of VEMP is based on the amplitude difference between the sides (Amplitude Asymmetry Ratio) and the latency.

Amplitude of VEMP depends, on the

- Level of the stimulus (high levels better)
- Frequency of the stimulus (low frequencies are better)
- Side of the stimulation (Ipsi is better)
- Tonicity of the SCM muscle (highly tonic is better)
- Latency of the VEMP is independent of all these factors (Akin, F.W., Murnane, O.D., & Medley, T., 2003).

VEMP is interpreted based on the asymmetry in amplitude between the sides; this is calculated with the following formulae (Gans 2005).

3.1. Amplitude Asymmetry Ratio (AAR) = [amplitude of left VEMP (AL) – amplitude of the right VEMP (AR)] / (AL + AR) X 100

Brandon, Musphy & Cohen (2006) performed a study with the objective of assessing the effects of different methods of sternocleidomastoid muscle (SCM) activation on vestibular evoked myogenic potentials (VEMP). Forty normal volunteers were tested using three different methods of SCM activation: sitting with the head turned away from the test ear (SIT), supine with the head held straight up (SHU), and supine with the head held up and turned away from the test ear (SHT). Dependent measures were latency, and amplitude. Head and body position significantly affected the amplitude of the VEMP, but had no significant effect on latency. Testing subjects in the supine position with the head up and turned toward the non-test ear yielded the most robust amplitude response and sternocleidomastoid EMG activity. When amplitude measures were corrected according to tonic electromyographic (EMG) activity no significant difference was noted between the three different test positions. The increased amplitude in the supine with head

turned position can be directly attributed to increased tonic SCM EMG activity.

Ito, Karino and Murofushi (2007) conducted a study on, Effect of head position on vestibular evoked myogenic potentials with toneburst stimuli. The study demonstrated the robustness of VEMP testing with toneburst stimuli, since it is hardly affected by head position, i.e. base or tonic excitation levels of the saccule and inferior vestibular nerve. However, the small but highly significant difference found in latency should not be neglected: the gravitational axis in the upright position may have some special effect on tonic excitation of the saccule. VEMPs were recorded with short tonebursts of 500 Hz in 14 normal subjects in 5 head positions (upright, nose up, ear up, nose down, and ear down). The three parameters analyzed were: 1) latency of p13, 2) latency of n23, and 3) corrected amplitude of p13-n23 (CA p13-n23). Results. One-way repeated measures ANOVA showed significant effects on both p13 ($p=0.0245$) and n23 ($p<0.0001$) latencies, but not on CA p13-n23. Bonferroni's post hoc test demonstrated that there were significant differences in n23 latency between the upright position and all other head positions leaning on the bed.

Sandhu & Bell (2008) performed a study to find the effects of eye position on the vestibular evoked myogenic potential. The position of a subject's eyes during vestibular evoked myogenic potential (VEMP) recording significantly alters the magnitude of the response. This change is largely due to an alteration in the tonicity of the sternocleidomastoid muscle (SCM) caused by variations in the position of the eye. However, even if electromyographic (EMG) normalization is conducted effects of eye position remain. VEMPs were collected from 32 ears measured on 16 healthy subjects. The recordings were made unilaterally using the head turn method. The acoustic stimuli were 500 Hz air-conduction short tone bursts. VEMPs were measured in three recording conditions: (i) eyes in the same direction as head turn, (ii) eyes straight ahead, (iii) eyes in the opposite direction to head turn. All 32 ears tested showed a VEMP response with eyes in all three positions. Repeated measures analysis of variance (RM-ANOVA) verified an overall significant effect of eye position ($p<0.001$). Post hoc paired t tests revealed statistically significant differences between the eyes opposite and the other two conditions ($p<0.001$). Normalization of the VEMP magnitude using pre-stimulus EMG reduced the effect; however, some variability remained.

Need for the study: There is a lack of VEMP data on Indian population. The present study aims at finding the effect of posture on VEMP recording.

Method: The study was carried out in the department of Audiology and Speech Language Pathology, Kasturba Medical College, Manipal University.

Subjects: 20 subjects with no otological complaints, no complaint of any vestibular pathology in the age range of 18-30 years were selected for the study.

Instrument used: Intelligent hearing services

Procedure: Single channel recording was carried out using the test protocol listed in Table 1 below. The recording was done for 250 sweeps and repeated at least twice on each side.

| | |
|-----------------------------------|--|
| <i>Filter</i> | 10Hz to 1500Hz |
| <i>Amplifier gain</i> | 5000 |
| <i>Window</i> | 50ms |
| <i>Stimulus</i> | Click |
| <i>Presentation level</i> | 95 dBnHL |
| <i>Stimulus presentation rate</i> | 7.1/second |
| <i>Repetitions</i> | 2 runs of 250 sweeps of the stimuli |
| <i>Montage</i> | Inverting - Testing side SCM muscle Non-Inverting - Sternum Ground - Opposite SCM muscle |

Table 1: Test protocol

3.2. Patient positioning and instruction

The participants were first made to sit in the upright position with their head turned contra lateral to the stimulus ear. Patients were then made to lie down in supine position, instructed to turn their head away from the stimulus (test ear) so that the SCM muscle tonicity is increased. This position was maintained until 250 sweeps of the stimuli were presented. The recording was repeated so as to check the replica of the peaks.

4. Results and Discussion

VEMP recordings were carried out in both supine and upright posture and the latencies of P1 and n1 were noted in 20 subjects with normal hearing sensitivity and no hearing complaints. Paired t test was used to compare the latencies of p1 and n1 in both positions. Statistical evaluation showed no significant difference in p1 latencies in upright and supine position at $t(19) = 0.840$, $p > 0.05$. Also, there was no significant difference found in n1 latencies in both upright and supine position at $t(19) = 0.468$, $p > 0.05$.

The test results revealed no significant difference in p1 and n1 potentials in the two testing positions (upright and supine). The findings suggest that both the positions can be used effectively to record VEMP.

5. Future Scope

A similar study can be carried out with a larger sample size and with by using the two different types of VEMP procedures (Ocular and Cervical VEMP)

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