TEST RETEST RELIABILITY OF OCULAR VESTIBULAR EVOKED MYOGENIC POTENTIALS

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Abstract

Occular Vestibular Evoked Myogenic Potentials (oVEMP) responses have been consistently obtained in healthy individuals. Reports in literature have been suggestive of their utility in evaluating patients with vestibular disorders (Iwasaki et al., 2008 & 2009). Compared to Cervical VEMPs (cVEMPS), oVEMPs are less strenuous for the subjects to perform, and symmetrical responses can be easily obtained without monitoring background activation. As the oVEMP test gains popularity and worldwide recognition as a valid and reliable test of otolith function, it is likely to supplement cVEMP in the assessment of end organ function and act as a complementary technique when assessing central vestibular disorders. However, the clinical use of any test requires the establishment of reliability of the test and little is known about the test-retest reliability of oVEMPs (Isaradisaikul, Strong, Moushey, et al., 2008; Eleftheriadou, Deftereos, Zarikas, et al., 2008). Nguyen et al., (2010) reported about the test-retest reliability of oVEMP , however, smaller number of participants, larger gap between test and retest sessions and absence of fixed reference point for upward gaze may have played spoilsport and a better control at these variables may bring about a different result. So, the present study aimed at examining the test-retest reliability of the sound-induced oVEMP parameters. Monaural contralateral oVEMPS were recorded from 30 healthy individuals with normal audio-vestibular system and the test was repeated after a minimum gap of 1 week, keeping the other parameters constant. The obtained data was analyzed using Cronbach's alpha test. The results revealed excellent test-retest reliability for the amplitude parameters barring the asymmetry ratio, which showed fair-to-moderate reliability. The latencies also demonstrated fair-to-moderate test-retest reliability. These reliability values for oVEMP are better than those reported for cVEMP and could be attributed to a number of factors including smaller area of electrode placement making it less error prone, oVEMP being excitatory potential as opposed to cVEMP being inhibitory, and lesser fatigability of extra-occular muscles contrary to higher fatigability of the SCM muscle. The test-retest reliability values, thus, prove that the test is quite reliable and can be used clinically with confidence.

Key Words: *Otolith functions, SCM muscle, cVEMP*

Nearly a decade after the clinical use of the cervical Vestibular evoked myogenic potentials (cVEMP), Rosengren et al. (2005) and Iwasaki et al. (2007) reported about the incidence of extra-ocular potentials of vestibular origin in response to the bone-conducted skull vibrations. This laid the foundation stone for the discovery of the ocular VEMP (oVEMP). The subsequent literature (Todd, Rosengren, Aw, & Colebatch, 2007; Wang, Jaw, & Young, 2009) has brought out the possibility of obtaining oVEMP in response to the same auditory stimuli that have been used for evoking cVEMPs. The normal individuals have been shown to produce highly replicable waveforms in comparison to absence of any reproducible deflections in the electromyogram in the persons with vestibular abnormailities (Iwasaki, Smulders, Burgess, et al., 2008).

The oVEMP represents excitation of the extraocular muscles via the crossed vestibulo-ocular pathways. It is optimally recorded with maximum upward gaze with surface electrodes placed inferior to the eyes on the cheeks. The waveform, thus obtained, consists of a negativity occurring at approximately 10 ms, which has been popularly referred to as the n10 potential, followed by a positivity occurring at approximately 16 ms, which has been named as the p16 potential (Iwasaki et al., 2007). Of these waves, only the n10 response has been found to be both absent in patients with vestibular loss and present in patients with hearing loss but intact vestibular function. This may indicate towards non-vestibular origin or contribution to these later waveforms (Iwasaki et al., 2007).

oVEMP responses have been consistently obtained in healthy individuals. Reports in literature have been brimming with the positivity with regards to their usefulness in evaluation of cases with vestibular disorders (Iwasaki et al., 2008 & 2009). Moreover, oVEMPs have been found to be less strenuous for the subjects to perform in addition to being largely symmetrical even without monitoring the muscle activation. As the oVEMP test gains popularity and the world gets ready to embrace it as a valid and reliable test of otolith function, it is likely to supplement cVEMP in the assessment of end organ function and complement the assessment of central vestibular disorders.

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Although the normal cVEMP parameters and test-retest reliability in response to sound stimuli has been the subject of several investigations, sparce knowledge is available in the contemporary literature about the test-retest reliability of oVEMPs (Isaradisaikul, Strong, Moushey, et al., 2008; Eleftheriadou, Deftereos, Zarikas, et al., 2008). Nguyen, Welgampola and Carey (2010) reported excellent test-retest reliability for all peak-to-peak amplitudes and asymmetry ratio for clicks and fair to good reliability for the parameters of tone-burst. However, they included only 12 subjects for evaluating test-retest reliability which is a small number and use of a larger number of subjects may reveal a more real picture. In addition, by they used a wide gap between the test and retest sessions, which may be capable of inducing many other variables that could adulterate the results of retest sessionsand deflect the results in favour of inducing larger variabilty. Moreover, the authors demanded their participants to maintain maximum upward gaze. An absence of a fixed reference point may be a culprit in them obtaining slightly lower values for some of the oVEMP parameters.

Aim of the study

The main aim of the present study was to find out the test-retest reliability of the sound-induced oVEMP parameters.

Method

Thirty healthy individuals (12 male and 18 female) with a mean age of 35 years (range of 18 to 50 years) with normal audio-vestibular system, ensured by administering a detailed case history that included questions specific to balance disorders, served as the participants of the study. The retest was done on all the participants with a minimum gap of 1 week and maximum gap of 3 weeks between the evaluations. The participants were queried briefly about any untoward incident that may have resulted in audio-vestibular problems during the test retest interval. All subjects gave informed consent before undergoing the evaluations.

A Nicolet Viking Quest (version 8.1) evoked potential system with TDH 39 supra-aural earphones was used for acquiring VEMP. The subjects were seated comfortably in an upright position in a well illuminated acoustically treated test room with the ambient noise levels within the ANSI specifications (ANSI S3.1-1999). They were instructed to maintain maximum upward gaze by concentrating at a particular point placed on the ceiling during the recording. A break was given after each recording to avoid fatigue adulterating the results. The electrode montage consisted of a non-inverting electrode placed on the cheek approximately 3 mm below the eye and centred beneath the pupil, an inverting electrode placed 2 cm below the non-inverting electrode and a ground electrode placed on the forehead. The skin overlying the cheeks and the forehead was cleansed using Nuprep skin preparing gel. The silver-chloride electrodes with wiring lengths of 1.5 meters each were placed using the 10-20 conduction gel. The recording was contralateral alone as reports in literature (Marnane & Akin, 2009) have shown that contralateral oVEMPs are more replicable and higher in amplitude than ipsilateral their counterpart. The stimulus and acquisition parameters of oVEMP have been given in table 1.

Table 1.*Protocol for recording oVEMP.*

Stimulus	Acquisition
Type: 500 Hz tone burst **Ramping:** Default (as in tone-burst ABR) **Duration:** Default (as in tone-burst ABR) **Intensity:** 95 dB nHL **Polarity:** Rarefaction **Rate:** 5.1 Hz	**Epoch time:** 100 ms **Filter settings:** 1–1,000Hz **Amplification:** 30,000X **Sweeps:** 150

The statistical analysis of the obtained data was done using Cronbach's alpha test to obtain the test retest reliability of the oVEMP parameters. The α-values of greater than 0.7 were considered to have excellent reliability, those with lesser than 0.4 were considered to have poor reliability and the intermediate values were considered to have fair/moderate reliability. This scale of categorization is based on the scale used by Versino, Colnaghi and Callieco (2001), who used this for establishing the test retest reliability of cVEMP.

Results and Discussion

The resultant waveforms were analysed to identify the oVEMP peaks. Figure 1 shows a sample waveform acquired from one of the participants of the study.

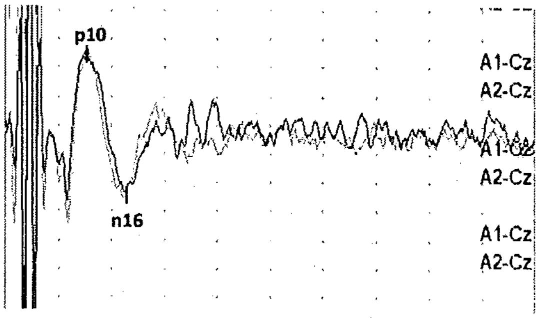

Figure 1: *Sample waveform acquired from one of the participants of the study.*

The n10 potential was identified as the first distinctive peak in the wave form, occurring approximately 10 to 13 ms after stimulus onset, and the p16 potential was identified as the first distinctive trough in the wave form, occurring approximately 14 to 18 ms after stimulus onset. The peak-to-peak amplitude was calculated as the sum of the n10 and p16 absolute amplitudes. The asymmetry ratio (AR) was calculated, in terms of percentage, by dividing the difference in peak-to-peak amplitudes of the two ears by the sum of the peak-to-peak amplitudes of the two ears.

Descriptive statistics

The mean and standard deviation values of the oVEMP parameters (p10 latency, n16 latency, p10 amplitude, n16 amplitude, peak-to-peak amplitude, threshold, and asymmetry ratio) for the first and second testing sessions are shown in Tables 2.

Table 2. *Mean and standard deviation values of different oVEMP parameters.*

	p10 latency [Mean (S.D.)in ms]	p10 amplitude [Mean (S.D.) in μV]	n16 latency [Mean (S.D.)in ms]	n16 amplitude [Mean (S.D.) in μV]	Peak-to-peak amplitude [Mean (S.D.) in μV]	oVEMP threshold [Mean (S.D.)in dB nHL]	Assymetry ratio [Mean (S.D.) in %]
Test session	11.21 (1.17)	4.55 (1.52)	15.43 (1.45)	3.72 (0.98)	7.38 (1.31)	84.40 (3.5)	21.67 (3.72)
Retest session	10.91 (1.04)	4.78 (1.43)	14.98 (1.51)	4.02 (1.06)	7.66 (1.27)	83.50 (4.5)	24.73 (5.16)

Test-Retest Reliability

Table 3 shows the Cronbach's α-values for oVEMP test-retest reliability. The amplitude parameters (p10, n16, and Peak-to-peak amplitudes) were found to have excellent reliability in response to tone-bursts of 500 Hz. Nguyen et al. (2010) also reported similar test-retest reliability. The excellent reliability of these oVEMP parameters is in contrast to several reports in literature about the cVEMPSs, which report the reliability to range from poor to moderate for most of the parameters (Isaradisaikul, Strong, Moushey, Gabbard, Ackley & Jenkins, 2008; Maes, Vinck, De Vel, D'haenes, Bockstael, Keppler, Phillips, Swinnen & Dhooge, 2009) This may be due to several basic differences that underlie the origin, electrode placement and task required by the participants to perform during the recording of the two sound induced vestibular potentials. First of all, the surface area of the cheek is smaller than that of the SCM muscle which makes the electrode placement less prone to error in terms of optimum placement. In addition, upward gaze may produce less fatigue in the muscle than does flexing or turning the neck, which may also lead to less inter-session variations (Fuchs & Binder, 1983). Also, there may be less variability in and soft tissue depth on the cheek than on the neck. Lastly, the oVEMP response is an excitatory potential measured in the midst of relatively small background noise of extraocular muscle activation. In contrast, the cVEMP response is a small modulation of a relatively noisy background of SCM contraction (Rauch, 2008). The former might be expected to be a more repeatable measure than the latter. The results of the present study tend to support the above mentioned arguments. The current study also found that the latencies of p10 and n16, peak-to-peak amplitude asymmetry ratios and threshold of oVEMP demonstrated fair-to-moderate reliability for tone-bursts and the above mentioned reasons appear to suffice explanation.

Table 3. *Test retest reliability (Cronchbach's α) values of oVEMP parameters.*

	p10 latency	p10 amplitude	n16 latency	n16 amplitude	Peak-to-peak amplitude	oVEMP threshold	Assymetry ratio
á-values	0.42	0.82	0.46	0.85	0.84	0.66	0.61

Conclusions

Ocular VEMPs may test a combination of utricular or saccular function, and the combination may depend on the stimulus being used. Although the exact otolith function being tested with oVEMPs is still a matter that awaits confirmation with more research, it appears that oVEMPs would plug several loopholes that their more conventional counterpart, the cVEMP, still has. These include greater overall reliability, less patient fatigue, and no need for correction for underlying muscle activity. As further research clears the clouds over the contributions from the utricular and saccular end organs to oVEMPs under specific testing conditions, the reliability and other advantages of oVEMPs should catapult the its usage in the years to come and make them a useful addition to the vestibular test battery.

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