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Cervical Vestibular Myogenic Potentials (C-VEMP) in Healthy Individuals: Comparison between Tone-Burst and Click

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Research Article

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Abstract

Introduction: Cervical Vestibular Evoked Myogenic Potential (c-VEMP) is one of the clinical tools to evaluate vestibular function. The c-VEMP can be recorded from sternocleido mastoid muscle by auditory stimulation with various sound stimuli. The aim of this study was to compare the VEMP responses evoked by tone-burst with those evoked by click stimuli in healthy young individuals.

Methods: Thirty healthy volunteers (15 males, 15 females; 60 ears). To perform the test, it was used an evoked potential equipment (Eclipse Platform, EP25, Interacoustic, Denmark) with a module for c-VEMP. To obtain the c-VEMP response, it was presented 200 monaural stimulation with tone burst and click, in a randomized way for each subject, with intensity 100dB HL at a frequency of 500 Hz.

Results: The sample consisted of 30 subjects, 15 women (50%) and 15 men (50%), aged 18-36 years. The mean age was 27.2 (±5.4). All subjects had c-VEMP responses in both tests, with both stimuli. The latencies p1 and n1 of tone-burst c-VEMP were significantly longer and the p1-n1 amplitudes were significantly greater as well.

Conclusion: A different database should be established before clinical application of c-VEMP for different stimuli. We recommend it because comparing tone-bur stand click, the latencies and amplitudes were significantly different, as observed among several labs.

Keywords: Potential; Vestibular system; Acoustic stimuli

Introduction

The cervical Vestibular Evoked Myogenic Potential (c-VEMP) is a complementar test for the vestibular disorders diagnosis, assessing the integrity of the vestibular-spinal reflex. This reflex depends on the integrity of the saccular macula, inferior vestibular nerve, vestibular nuclei, the vestibule spinal pathways and the effector muscle. It is essential for body balance because it helps to maintain and restore the stability of the head relative to the body during head movement [1]. Despite being relatively an old exam, discovered in the mid- 50s, it was included in the early 90s in clinical practice, increasing the number of studies about this exam. However, the applicability and standardization have been discussed in literature due to its methodological contrasts [2,3]. Standardized parameters for the test guarantee the accuracy of responses. The need for studies aimed at standardization of vestibular evoked myogenic potentials justifies the present study [2]. Several techniques have been developed to carry out VEMP. The effects of different intensity, frequency and type of acoustic stimuli, patient positioning during the examination, electromyographic activity and placement of electrodes, have been widely discussed in the literature [1-5].

Objectives

Compare values for clinical interpretation of the responses of c-VEMP with two different types of acoustic stimuli (click *versus* tone-burst).

Materials and Methods

The research was conducted at Pedro Ernesto University Hospital. It was selected adult subjects, of both genders, with no otoneurological complaints (hearing loss, dizziness and tinnitus). All subjects had an ENT evaluation and passed the hearing-screening test of 20 dBHL from 250 to 8.000 Hz using a clinical pure tone audiometer. The tympanometry of the subjects were type A. Subjects with medical history of ear disease and vestibular disorder were excluded from the study. To perform the c-VEMP, it was used an evoked potential equipment (Eclipse Platform, EP25, Interacoustic, Denmark). Before placing the electrodes, skin friction was held with abrasive paste (Neurograff Eletromedicine, Sao Paulo, Brazil) with gauze. Surface electrodes were used 3M (Minnesota, United States). To transmit the sound stimuli, insert earphones (Ear tone, Audiometric Insert Earphones, Minnesota, USA) were selected according to the interpersonal anatomical variation.

The assets right and left electrodes were placed in the middle third of the SCM muscle by offering higher amplitudes and more consistent responses according literature. The ground electrode was placed on the forehead and the reference in the sternal notch. The impedance of the electrodes was checked and should not exceed 5 K ohms. During the examination, the subjects remained seated in upright position and should turn the neck against the stimulated ear, staring at a pre-established fixed spot in order to maintain maximum muscle contraction. Electromyography (EMG) monitored the activity of the SCM muscle with maximum of 180μV contraction. To obtain the c-VEMP response, it was presented 200 monaural stimulation with tone-burst and click, in a randomized way for each subject evaluated, with intensity 100dB HL at a frequency of 500 Hz. All tests were performed and analyzed by different prepared professionals for bias prevent. For statistical analysis, it was used MINITAB (Software version 1.4). For purposes of descriptive analysis, the categorical variables proportions were studied and the measures of central tendency (mean and median) for continuous variables and their respective standard deviations were calculated. For comparative analysis concerning VEMP responses (latencies and amplitudes) between the side and gender, were used the ANOVA test. The significance level was set at 5% (p= 0.05). The variables analyzed were: type of sound stimuli (click and tone-burst), gender, age, laterality and asymmetry ratio.

Results

The sample consisted of 30 subjects, 15 women (50%) and 15 men (50%), aged 18-36 years. The mean age was 27.2 (± 5.4). All subjects had c-VEMP responses in both tests, with both stimuli. In this sample, using tone-burst stimuli, P1 wave showed a mean latency of 17,78ms (± 2.01) and mean amplitude of -56,07μV (± 17.61). While the N1 wave showed a mean latency of 25,9ms (± 1.96) and mean amplitude of 83,74μV (± 31.36). Peak to peak amplitude (P1-N1) was 139,82μV (± 47.32). Asymmetry index 27.84% (± 26.06) and Interpeak 8, 13ms (± 1.44).

TB VEMP		Mean	SD	Median	Min	Max
P1 Latency	Ms	17.78	±2.01	17.75	14.67	23.34
N1 Latency	Ms	25.92	±1.96	25.84	23	32
P1 Amplitude	μV	-56.07	±17.61	56.93	-88.25	-23.55

N1 Amplitude	µV	83.74	±31.36	87.81	24.48	138.15
IA	%	26.06	±20.94	21.64	1.14	76.95

Table1: c-VEMP responses obtained with tone-burst stimuli. Pedro Ernesto University Hospital UERJ-RJ Brazil N=30.

Using click stimulus the P1 wave showed a mean latency of 14ms (± 2.49) and mean amplitude of -31,29µV (± 10.5). While the N1 wave showed a mean latency 20,97ms (± 1.87) and mean amplitude of microvolts 42.68 (± 14.03). Peak to peak amplitude (P1-N1) 73,98µV (± 22.27). Asymmetry index 22.40% (± 30.52) and Inter-peak 6.95ms (± 1.89).

C VEMP		Mean	SD	Median	Min	Max
P1Latency	Ms	14	±2.49	13.67	10.17	20
N1 Latency	Ms	20.97	±1.87	20.76	18.67	27
P1 Amplitude	µV	-31.29	±10.5	-31	-57.10	-14,20
N1 Amplitude	µV	42.68	±14.03	40.72	16.31	71,08
IA	%	22.40	±30.52	20.81	1.84	45

Table 2: c-Vemp the responses obtained with click stimuli. Pedro Ernesto University Hospital UERJ-RJ Brazil N=30.

No statistically significant differences were found when comparing the variables gender and age in any of the techniques applied. Corroborating to literature. Although there is no statistically significant difference when comparing the stimuli of asymmetry indexes for click and Tone-burst, it is possible to suggest the trend of click stimuli (22.40% ± 30.52) to have smaller asymmetry indices than the tone-burst (26.06%±20.94). The asymmetry index was calculated according to the following scheme:

$$Asymmetry\ Index = \frac{(Higher\ value\ -\ lower\ value\ between\ ears)}{(Higher\ value\ +\ lower\ value\ between\ ears)} * 100$$

There was no statistical difference between the latencies of left and right afferents in any technique used.

	Tone Burst	Click		
P1	**Mean**	**SD**	**Mean**	**SD**
P1 LAT R	17.77	2.28	14.08	2.81
P1 AMPL R	-55.41	19.90	-31.61	15.46
P1 LAT L	17.80	2.18	13.97	2.53
P1 AMPL L	-56.73	20.68	-31.00	9.57
N1				
N1LAT R	25.82	2.11	20.99	2.10
N1 AMPL R	83.80	38.34	43.87	16.54
N1 LAT L	26.01	2.24	20.96	1.96
N1 AMPL L	83.68	33.26	41.50	15.11

Table 3: Comparison of the mean values and standard deviations of c-VEMP tone-burst stimuli and c-VEMP stimuli according to laterality Pedro Ernesto University Hospital UERJ-RJ Brazil N=30.

	Tone Burst		Click	
	Mean	**SD**	**Mean**	**SD**
P1 Latency (ms)	17.78	±2.01	14	±2.49
N1 Latency (ms)	25.9	±1.96	20.97	±1.87
P1-N1 Interval (ms)	8.13	±1.44	6.95	±1.89
P1 Amplitude (µV)	-56.07	±17.61	-31.29	±10.5

N1 Amplitude (µV)	83.74	±31.36	42.68	±14.03
P1-N1 Amplitude (µV)	139.82	±47.32	73.98	±22.27
Asymmetry Ratio	26.06%	±20.94	22.40%	±30.52

Table 4: Comparison of the mean and standard deviation of the c-VEMP tone-burst stimuli and c-VEMP click stimuli Pedro Ernesto University Hospital UERJ-RJ Brazil N=30.

VEMPs	*N*	Age	P1(ms)	N1(ms)	P1-N1(µV)	AR
Wu & Young	10	24-35	14.90±0.5	20.13±0.44	NA	0.13±0.12
Cheng	29	17-43	12.49 ±0.94	19.79 ±1.40	102.84 ±44.56	NA
Wu Huei-Jun	22	17-30	14.83 ±0.17	22.54 ±0.27	198.53 ±64.64	0.13 ±0.02
Presente Study	30	18-36	17.78 ±2.01	25.90 ±1.96	139.82 ±47.32	0.26±0.21

Table 5: c-VEMP with tone-burst stimuli in similar studies.

VEMPs	*N*	Age	P1(ms)	N1(ms)	P1-N1(µV)	AR
Cheng et al	29	17-43	11.45 ±0.87	19.17±1.55	119.55±44.03	NA
Wu Huei-Jun	22	17-30	12.43 ±0.21	19.85 ±0.35	81.23±32.56	0.20±0.02
Presente Study	30	18-36	14 ±2.49	20.97 ±1.87	73.98 ±22.27	0.22±0.30

Table 6: c-VEMP with click stimuli in similar studies.

Discussion

According literature, age may influence VEMP responses due to the deterioration of the saccule, neural disfunction of this reflex, vestibular hair cells and ganglia of Scarp degradation with advancing age. The expected differences are: delayed N1 latency and decreased wave amplitude with advancing age. Therefore, it is recommended to have standardized parameters for different age groups. By this fact, this study addressed the findings in VEMP in young adults [1-4,6]. The amplitude can be influenced by muscular contraction level .The effect of age on VEMP amplitude waves is probably related to the change in thickness of the SCM muscle. Muscle contraction is a crucial factor for obtaining VEMP waves. If the muscle contraction is insufficient, there will be no record of waves. There was frequent monitoring EMG during the test, so that only the vestibular responses could have taken into account [7-9].

Few studies have demonstrated that c-VEMP response with click stimulus had a higher response rate, a shorter latency and larger amplitude than tone-burst. However, most studies showed significant differences between these two stimuli. The P1 and N1 latencies were higher with tone-burst as well as the amplitude when compared to the click. Thus, the use of tone-burst stimulus becomes more feasible [8]. The longer latency with tone-burst may be a result from a delay of tone-burst stimulus to reach the maximum intensity. Moreover, the vestibular neurons may have double or triple firing to one tone-burst stimulus and the latencies of VEMP responses might be delayed because of the second or third spikes [10-13]. The tone-burst had longer latencies P1 and N1 than click, justifying norms of different stimuli for clinical interpretation [14,15]. The findings of this study corroborate what the literature shows that there is great difference between the VEMP latencies generated by click and tone-burst stimulus. The results suggest the assessment of VEMPs latencies using normative values obtained according to the parameter of each stimulus [15,16].

Conclusion

c-VEMP responses elicited by click stimuli are significantly different from those obtained with tone-burst. Tone-burst stimulus results in higher latencies P1 and N1 as well as larger amplitudes. The findings of the study confirm the need to establish normative data for each stimulus in question.

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