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Cervical vestibular evoked myogenic potentials in children☆

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KEYWORDS
Postural balance;
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Abstract
Introduction: Cervical vestibular evoked myogenic potential is a test used in neurotological examination. It verifies the integrity of vestibular function through a muscular response evoked by an acoustic stimulation which activates the saccular macula. Normal standards in adults have been established, however, there are few published data on the normal responses in children.
Objective: To establish normal standards for vestibular myogenic responses in children without neurotological complaints.
Methods: This study's design is a cohort with cross-sectional analysis. The sample consisted of 30 subjects, 15 females (50%) and 15 males (50%).
Results: The age of the subjects ranged between 8 and 13 years, with a mean of 10.2 (± 1.7). P1 peak showed an average latency of 17.26 (± 1.78) ms and a mean amplitude of 49.34 (± 23.07) μV, and the N2 peak showed an average latency of 24.78 (± 2.18) ms and mean amplitude of 66.23 (± 36.18) μV. P1–N2 mean amplitude was 115.6 (± 55.7) μV. There were no statistically significant differences when comparing by gender or by laterality.
Conclusion: We established normal values of cervical myogenic vestibular responses in children between 8 and 13 years without neurotological complaints.
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PALAVRAS-CHAVE
Equilíbrio postural;
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Potenciais evocados miogênicos vestibulares;
Diagnóstico

Potencial evocado miogênico vestibular cervical em crianças

Resumo
Introdução: O potencial evocado miogênico vestibular cervical (cVEMP) vem sendo empregado como exame complementar em estudos otoneurológicos. Avalia a função vestibular através da resposta muscular originada a partir de uma estimulação acústica que ativa a mácula sacular. O exame foi padronizado em adultos, entretanto, há escassez de dados publicados sobre as respostas obtidas em crianças.
Objetivo: Estabelecer valores de normalidade das respostas miogênicas vestibulares em crianças sem queixas otoneurológicas.
Método: Estudo de coorte histórica com corte transversal, de 30 sujeitos sem queixas otoneurológicas, 8 a 13 anos.
Resultados: A amostra foi composta de 15 meninos e 15 meninas, com idade média de 10,2 (± 1,7 anos). A curva P1 apresentou uma latência média de 17,26 (± 1,78) e uma amplitude média -49,34 (± 23,07), enquanto a curva N2 apresentou uma latência média de 24,78 (±2,18) e uma amplitude média de 66,23 (± 36,18). A amplitude P1–N2 foi 115,6 (± 55,7). O índice de assimetria foi de 21,3% (± 18,6). Não foram encontradas diferenças estatisticamente significativas quando comparados os sexos. Da mesma forma, não se observou efeito significativo da lateralidade nos resultados.
Conclusão: Foram estabelecidos os valores de normalidade das respostas miogênicas vestibulares cervicais em crianças entre 8 e 13 anos sem queixas otoneurológicas.
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Introduction

The cervical vestibular-evoked myogenic potential (cVEMP) has been utilized as a supplementary test in neurotological disorders and in the evaluation of vertigo. This is a test that assesses the vestibular function through a reflex muscle response in response to a high-intensity acoustic stimulation that activates the saccular macula.

The reflex that originates in the sacculus is transmitted to neurons in the ganglion of Scarpa, advances through the inferior vestibular nerve, vestibular nucleus and vestibular-spinal tract, and terminates in the motor neurons for the sternocleidomastoid muscle.[1–3]

It is estimated that childhood vertigo represents 1% of the consultations in pediatric neurology. This problem is also found in 13% of children referred for audiologic evaluation.[4] That percentage may be even higher, due to difficulties in establishing the diagnosis and obtaining an adequate history from a child with dizziness, due to a difficulty in describing the discomfort. However, pediatric vestibular disorders are of great importance, because they can cause a number of effects, such as delayed motor and learning development, potentially interfering in language, speech, writing and reading.[4,5]

Among the complementary tests in an otoneurologic evaluation, advantages of VEMP are that it is an objective, reliable, noninvasive, inexpensive, easy to perform, and rapid test that causes the patient no discomfort.[2,6–8]

The test has been standardized in adults, and its normal values have been defined.[8–11] However, there are few published data on the responses obtained in children. There is no Brazilian standardization for this test in the pediatric population, which limits its applicability in clinical practice.

The aim of this study was to establish normal values for vestibular myogenic responses in 8–13 year old children without otoneurologic complaints.

Methods

The study was approved by the Research Ethics Committee (Opinion number 421.510). All parents/guardians signed the Free Informed Consent for participation of their children in the research. This is a cross-sectional historical cohort study. The study group consisted of 30 subjects of both genders without otoneurologic complaints, who were aged 8–13 years.

Exclusion criteria were: no agreement of parents/guardians and children to participate in the study; the patient did not fit to the studied population; cervical rotation difficulty; external-middle ear malformation; dizziness, tinnitus or other otoneurologic complaints; presence of conductive hearing alteration (type B tympanogram and absence of stapedial reflexes); and hearing loss.

All children's parents and/or guardians were informed about the study objectives and, after due authorization, the examination was performed.

The subjects were submitted to cVEMP in a quiet and comfortable room, previously reserved for the examinations. The tests were performed by two female speech therapists.

To perform cVEMP, an Interacoustics Eclipse device with a module for cVEMP was used. Stimuli were sent through Ear Tone ABR insertion headphones.

The volunteers remained seated in a chair and, after rubbing the skin with an abrasive paste (Neurograff

Table 1 Mean values and standard deviations of cVEMP curve parameters in 30 children.

	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
P1						
P1 latency, right ear	17.11	1.51	16.80	1.28	16.96	1.38
P1 amplitude, right ear	−46.61	19.94	−47.64	21.89	−47.13	20.58
P1 latency, left ear	17.36	2.36	17.78	1.82	17.57	2.08
P1 amplitude, left ear	−46.97	19.56	−56.15	30.29	−51.56	25.48
P1 asymmetry index	13.35	10.79	20.20	14.34	16.78	12.94
N2						
N2 latency, right ear	24.69	2.22	24.47	1.92	24.58	2.04
N2 amplitude, right ear	62.10	32.54	67.90	37.99	65.00	34.88
N2 latency, left ear	24.96	2.62	25.04	2.12	25.00	2.34
N2 amplitude, left ear	59.89	37.86	75.04	37.88	67.47	38.00
N2 asymmetry index	12.20	10.28	17.92	13.73	15.06	12.27

PS, no significant differences between genders.
No significant difference between body sides (L and R).

Eletromedicina), electrodes (ECG Conductive Adhesive Meditrace, Kendall) were attached. The surface electrodes were placed on the following positions: active electrode on the middle third of the sternocleidomastoid (SCM) muscle, reference electrode on the xiphoid of the sternum, and ground electrode on the forehead.[8] After placement of the electrodes, the impedance among the electrodes was recorded. The impedance values were checked before each recording, and impedance values between electrode pairs of up to 3 kΩ were accepted.

The volunteer was instructed to turn his/her head to the opposite side in relation to the stimulated ear, resulting in SCM muscle contraction.[8,12–14] The stimulus was initiated by right afferency and then, left afferency. The responses were replicated, that is, they were recorded twice in a row on both sides. It is important to document the reliability of the evoked potential, so that the subjectivity and variability of interpretations are eliminated.[15]

cVEMP tracings were obtained in the form of biphasic waveforms: negative-positive, P1–N2. The results were obtained after monaural stimulation. The acoustic stimulus used was a rarefied tone burst, with an intensity of 100 dB Na. To obtain the waveform, 200 stimuli with frequency of 500 Hz were presented. The analysis window was 80 ms.

The variables studied were: gender; date of birth; latency to onset of P1 wave; latency to onset of N2 wave; value of P1- and N2-amplitude; and asymmetry index.

For purposes of descriptive analysis, the proportions of categorical variables were studied, and the measures of central tendency (mean, median) of continuous variables were calculated, as well as their respective standard deviations. For comparative analyzes concerning cVEMP responses (latencies and amplitudes) between the evaluated body sides and also in relation to gender, the ANOVA test was used. The level of significance was set at 5% ($p = 0.05$).

Results

The sample consisted of 30 subjects, 15 females (50%) and 15 males (50%). The age of the subjects ranged from 8 to 13 years, with a mean of 10.2 (± 1.7) years.

Table 2 Correlations (Spearman) between latencies and amplitudes of cVEMP curves and age of participants.

	rho	*p*
P1 latency (ms)	0.079	0.549
P1 amplitude (μV)	−0.276	0.033
N2 latency (ms)	0.339	0.008
Amplitude N2 (μV)	0.383	0.003

In this sample, the P1 peak showed a mean latency of 17.26 (± 1.78) ms and a mean amplitude of 49.34 (± 23.07) μV, while the N2 peak had a mean latency of 24.78 (± 2.18) ms and a mean amplitude of 66.23 (± 36.18) μV. The P1–N2 amplitude was 115.6 (± 55.70) μV. The asymmetry index was 21.3% (± 18.6%). The mean values of latencies and amplitudes of cVEMP curves, according to the laterality, are shown in Table 1.

Statistically significant differences were not found, when comparing genders. Similarly, there was no significant effect of laterality in the results.

Increasing age was accompanied by a significant increase in the amplitudes of the peaks P1 and N2 and by an increase in the latency of N2, but not of P1 (Table 2).

Discussion

cVEMP is a relatively new test, which is still in the process of validation in studies with patients with specific vestibular disorders.

The selected stimulus was a tone burst at a frequency of 500 Hz, since this stimulus is more effective than clicks for obtaining cVEMP.[16,17] Frequencies ≤500 Hz are the most often used, resulting in more homogeneous and constant responses.[11,16–19]

Although the literature reports some differences from various positions of the surface electrodes in cVEMP studies, generally electrodes positioned at the middle third of SCM muscle result in more consistent and homogeneous responses.[19] It is possible to use other muscles for cVEMP recording,[11,20] but in this study, we used the most commonly used SCM.[17,21]

Several methods have been described for SCM muscle activation during the examination.[8,12,22–24] We used head rotation. There are reports using either head rotation or elevation,[12,16,17,25,26] and the responses are similar.[26,27] The head rotation method is preferred for younger or older subjects, because of the ease of maintaining that position.[14,26] The low asymmetry index we found validates that method for cVEMP recording in this age group.

The latency and amplitude values we found in this study are similar to those reported in the literature in similar age groups (4–19 years). In other pediatric samples without otoneurologic disease using the head rotation method, the mean latency of P1 ranged between 11.3 and 15.4 ms, the mean latency of N2 ranged from 18.2 to 23.7 ms, and the mean total amplitude ranged from 126.7 to 160.5 μV, with asymmetry indices between 16–20%.[12–14,18] The differences observed among studies are probably explained by the use of different devices, hence the importance of standardizing the reference values by type of equipment.

Increasing age was accompanied by a significant increase in peak P1 and N2 amplitudes, and by an increased latency of N2, but not of P1. The effect of age on the amplitude of cVEMP waves is probably related to the change in thickness of the SCM muscle.[28] Thus, older children, with more developed muscles, exhibit higher amplitudes. As no age effects were observed with respect to P1 latency, the increase of N2 latency is probably associated with a longer duration of P1 wave. This also may depend on muscular factors, and not on the conduction velocity through the nerve pathway.

The sample size was adequate to estimate the mean of latencies for the population, assuming a less than 5% difference with respect to the observed mean and with 80% power. Considering that the amplitudes showed a higher coefficient of variation, the sample size was adequate to estimate their population means, assuming differences below 30%.

Conclusion

Normal values for cervical vestibular myogenic responses were established in children aged 8–13 years without otoneurologic complaints. Given its limited sample size, this study deserves replication.

Conflicts of interest

The authors declare no conflicts of interest.

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