

# Auditory evoked potentials in peripheral vestibular disorder individuals

## Potenciais evocados auditivos em indivíduos com síndrome vestibular periférica

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### SUMMARY

**Introduction:** The auditory and vestibular systems are located in the same peripheral receptor, however they enter the CNS and go through different ways, thus creating a number of connections and reaching a wide area of the encephalon. Despite going through different ways, some changes can impair both systems. Such tests as Auditory Evoked Potentials can help find a diagnosis when vestibular alterations are seen.

**Objective:** describe the Auditory Evoked Potential results in individuals complaining about dizziness or vertigo with Peripheral Vestibular Disorders and in normal individuals having the same complaint.

**Methods:** Short, middle and long latency Auditory Evoked Potentials were performed as a transversal prospective study.

**Conclusion:** individuals complaining about dizziness or vertigo can show some changes in BAEP (Brainstem Auditory Evoked Potential), MLAEP (Medium Latency Auditory Evoked Potential) and P300.

**Keywords:** auditory evoked potentials, dizziness, vestibular disorders.

### RESUMO

**Introdução:** Os sistemas auditivo e vestibular estão localizados no mesmo receptor periférico, porém adentram ao SNC e percorrem caminhos distintos, estabelecendo uma série de conexões e abrangendo uma vasta região do encéfalo. Mesmo percorrendo caminhos diferentes, algumas alterações podem comprometer ambos os sistemas. Testes como os Potenciais Evocados Auditivos podem auxiliar no diagnóstico com alterações vestibulares.

**Objetivo:** Caracterizar os resultados dos Potenciais Evocados Auditivos de indivíduos com queixa de tontura ou vertigem com Síndromes Vestibulares Periféricas e com indivíduos normais, com a mesma queixa.

**Método:** Foram realizados os Potenciais Evocados Auditivos de curta, média e longa latência, sendo um estudo prospectivo transversal.

**Conclusão:** Indivíduos com queixa de tontura ou vertigem podem apresentar alterações no PEATE, PEAML e P300.

**Palavras-chave:** potenciais evocados auditivos, tontura, doenças vestibulares.

## INTRODUCTION

Dizziness and vertigo have many etiological factors (3, 4, 5, 6, and 7). Several signs of vestibular dysfunction can be detected by anamnesis, clinical test, otoneurological test, as well as tests evaluating the auditory system (8). Tests such as auditory evoked potentials (AEP) help diagnose individuals with vestibular disorders (1).

Some authors indicate the presence of Brainstem Auditory Evoked Potential (BAEP) abnormalities in individuals with vertigo or dizziness, and this finding is more frequent when the impairment source is central (3, 9, 10, 11). Other studies with vertigo or dizziness, in which the etiology was not established for all individuals, observed an increase in the interpeak III-V or absence of waves III and/or V (11), as well as an increase in latencies of waves I, III and V (10,13).

Studies relating the Middle-Latency Auditory Evoked Potential (MLAEP) and the Cognitive Potential (P300) to vestibular disorders are scarce.

Considering the high incidence of dizziness or vertigo, the associations between the auditory and vestibular systems and AEP tests, which help diagnose, the objective of this study was to characterize the results of AEP individuals with Peripheral Vestibular Syndromes (PVS), by comparing them with normal individuals with dizziness or vertigo.

## METHOD

This study was conducted in the University of São Paulo's Hospital's Department of Audiology and in the Laboratory of Phonoaudiological Research in Auditory Evoked Potentials of the Degree of Phonoaudiology of the University of São Paulo's Medical School's Department of Physiotherapy, Phonoaudiology and Occupational Therapy. It was approved by the Ethical Committees of the institutions in which it was performed under protocol number 0311/08. The Free and Clarified Term of Agreement was signed by all the individuals in the study.

The sample consisted of 44 individuals, out of whom 15 had vestibular exams suggestive of Deficit Peripheral Vestibular Syndrome (DPVS), belonging to the study group 1 (SG1), 15 suggestive of Irritating Peripheral Vestibular Syndrome (IPVS), belonging to the study group 2 (SG2) and 14 had normal vestibular exams and vertigo or dizziness disorder, belonging to the control group (CG). To integrate the sample, the following inclusion criteria have been adopted: age between 18 and 60; completion of

vestibular exam suggestive of IPVS, DPVS or normal vestibular exam with dizziness or vertigo disorder; auditory thresholds until 55 dB NA in the frequency range from 250 to 2000 Hz, as well as the average of hearing thresholds in frequencies from 3000 to 6000 Hz to 60 dB NA (with the intent to excluding hearing changes that could influence the AEP results).

It is noteworthy that the average age was 52.2 in CG, 52 in 46.6 in SG1 and SG2. The overall average of frequencies from 500 to 2000 Hz was 9.6 dB NA for the CG, 12.8 and 12.1 dB NA for groups SG1 and SG2, respectively. The overall average in frequencies from 3000 to 6000 Hz was 14; 20.5 and 17.3 dB in for the CG, SG1 and SG2, respectively.

The individuals were firstly submitted to the anamnesis, inspection of the external acoustic meatus, audiologic evaluations (pure-tone and vocal audiometry), measures of immittance audiometry and vestibular exams (vectoelectronystagmograph and calorie tests). Based on these results, in compliance with the adopted inclusion criteria, the sample was selected. Secondly, the electrophysiological hearing tests were performed in the following order: P300, MLAEP and BAEP. P300 was the first to be performed, as it requires the patient's attention to be performed.

The tests were conducted on electrically protected and quiet environment.

The equipment used was: Heine otoscope; Grason Stadle GSI-33 middle ear analyzer and GSI-61 audiometer; VECWIN Digital Vectonystamograph equipment and Neurograff OAT-10 visual stimulator and otocalorimeter; Biologic Traveler Express portable equipment for AEP capture; and the electrodes were attached to the skin in predetermined positions, according to Standard International Electrode System (IES) rule 10-20.

In P300, the acoustic stimulus used was the monaurally presented toneburst at 75 dB NA at a presentation speed of 1.1 stimuli per second, and a total of 300 stimuli was employed. The electrodes were placed on the vertex (Cz), frontal (Fz) and on the right and left ears (A2 and A1). The individual was guided to identify and count the rare stimuli (1,500 Hz frequency), which randomly appeared, in a series of frequent stimuli (frequency of 1,000 Hz). The values of P300 wave latency were analyzed by using as normal values those proposed in the literature (14).

In MLAEP, the acoustic stimulus was used and monaurally presented at 70 dB NA at a presentation speed of 10 stimuli per second, and a total of 300 stimuli was

employed. The electrodes were fixed on the vertex (Cz), frontal (Fz) and on the right and left ears (A2 and A1), as well as in the right and left temporal-parietal joints (C4 and C3). The latencies of Na and Pa waves and Na-Pa width were recorded for the ipsilateral (C3/A1 and C4/A2) and contralateral (C3/A2 and C4/A1) modes. The values of latencies Na, Pa and Na-Pa amplitude were analyzed as per the one proposed in the literature (15, 16).

INBAEP, the electrodes were placed on the forehead (Fz) and in the mastoids of left and right ears (A2 and A1), and the impedance values of electrodes were lower than 5 kOhms. The acoustic stimulus used was the click of rare polarity and duration of 0.1 ms, monaurally presented at 80-dB intensity. The presentation speed was 19.1 stimuli per second and total of 2,000 stimuli was used. Two traces were obtained in each ear. The analysis was performed based on the absolute latencies of waves I, III and V and interpeaks I-III, III-V and I-V. The results were classified as normal and changed, taking into consideration two standard deviations, varying with the normality established for individuals above 24 months of age, suggested by the manual of the equipment used.

The quantitative data went through a descriptive statistical analysis (mean, median and standard deviation) and inferential (T test). The significance level was 0.05, and the groups were compared two-by-two.

For the quantitative analysis, a comparison of the normal and changed results was made by the Chi Square test. To classify the results as changed, it was necessary that at least one ear was impaired and one of the analyzed parameters was changed. To classify as normal, it was necessary that both ears showed results within normality. The significance level was 0.05, and the groups were compared two-by-two.

## RESULTS

Below, the results achieved in the electrophysiological hearing evaluations will be presented.

At Table 1, the results for the qualitative data analysis of latencies of waves of BAEP, MLAEP and P300, CG, groups and SG1 SG2 are present.

Significant differences were observed in the P300 in comparison of CG with SG1; and in MLAEP when comparing the CG with SG1 and SG2.

In MLAEP, the PVS groups (SG1 and SG2) had bigger differences in the results for the Pa wave latency compared with the CG. In turn, for the Na-Pa width, it cannot be affirmed that the groups are different, because the p-values were above the level of significance.

The tables below present the quantitative results.

At Table 2, the descriptive measures of the results achieved in the P300 in the three groups are shown.

Comparing the results obtained by P300 latency, no statistically significant difference was observed between the groups.

At Table 3, the results of the descriptive statistics of the Pa-MLAEP width for the CG, SG1 and SG2 groups are present. With respect to In-Pa width, no statistically significant difference was found when comparing the three groups.

For Na and Pa wave latencies, no statistically significant difference was observed either.

**Table 1.** Distribution and comparison of the occurrence of normal and changed results in CG, SG1 and SG2, the latencies of the waves of BAEP, MLAEP and P300.

		N			Chi Square Test		
		CG	SG1	SG2	CG X SG1	P-value CG X SG2	SG1 X SG2
P300	Normal	13	11	13	0.0022*	0.3173	0.2429
	Changed	1	4	2			
MLAEP	Normal	13	8	10	0.0000*	0.0000*	0.3006
	Changed	1	7	5			
BAEP	Normal	9	9	11	0.6547	0.4221	0.2918
	Changed	5	6	4			

Legend: \* statistical difference (p-value < 0.05).

**Table 2.** Descriptive measures of the P300 wave latency (in milliseconds - ms) in CG, SG1 and SG2.

	N	Median	T		Test		
			Average	Standard Deviation	CG x SG1	P-value CGxSG2	SG1xSG2
CG	28	356.3	354	32.79	0.675	0.183	0.099
SG	30	360.3	360	38.60			
SG2	30	343.6	340	38.43			

**Table 3.** Descriptive measures of the Na-Pa amplitude (in microvolts -  $\mu$ V) of the MLAEP, in CG, SG1 and SG2.

		N	Median	T		Test		
				Average	Standard Deviation	CG x SG1	P-value CGxSG2	SG1xSG2
C3/A1	CG	28	3.09	2.71	3.11	0.84	0.68	0.41
	SG1	30	3.29	2.66	2.02			
	SG2	30	2.7	2.25	1.9			
C4/A1	CG	28	2.31	1.96	1.25	0.72	0.56	0.70
	SG1	30	2.47	2.38	1.17			
	SG2	30	2.76	2.33	2.54			
C3/A2	CG	28	3.67	1.94	4.51	0.69	0.90	0.50
	SG1	30	3.13	2.12	2.54			
	SG2	30	3.87	2.86	3.3			
C4/A2	CG	28	2.27	1.56	1.96	0.55	0.30	0.66
	SG1	30	2.76	2.03	2.4			
	SG2	30	3.16	2.2	2.55			

Table 4 presents the results of the analysis of BAEP quantitative data.

A statistically significant difference was observed only in interpeak III-V, between the CG and the SG1.

## DISCUSSION

In this study, analyzing the P300 and MLAEP in all groups, the results were changed results with a greater occurrence of change in SG1 followed by SG2. In the analysis of qualitative data, the groups were statistically different in both electrophysiological tests. In P300, the SG1 differed from CG differed; and in MLAEP, the SG1 and SG2 groups differed from the CG primarily for the latency of Pa wave (Table 1).

These findings demonstrated that patients with dizziness or vertigo, when compared to the normal range used (14,15, and 16), may show changes in the MLAEP and P300. In P300, those with vestibular exam suggestive of DPVS tend to have more changes in comparison with normal vestibular individuals. In MLAEP, in individuals with vertigo or dizziness, vestibular examination suggestive of

SVP predicts further changes, particularly with respect to Pa wave.

No study in the reviewed literature correlates the P300 and MLAEP with PVS. However, greater occurrence of changes in P300 in groups SG1 and SG2 may be explained by the disorders of memory, attention or concentration, which have been previously reported in PVS patients (17,18), or a central auditory dysfunction, since P300 evaluates this aspect (19,20,21). The changes found in the MLAEP probably reflect CNS disorders, due to the location of their generators (20).

In the quantitative analysis of P300 and the MLAEP, there was no significant difference (Tables 2 and 3). This finding suggests that in these exams, in individuals with complaints of dizziness or vertigo, average values found for the P300 and latencies of Pa and Na waves of MLAEP, as well as the Na and Pa width, are independent of the result of vestibular exam (DPVS, IPVS or normal). However, when comparing results based on the group average, the most extreme values cannot be emphasized because they are "diluted" in the overall average. Thus, the classification as normal and changed seems to give us more information about the MLAEP and P300 in individuals with dizziness or vertigo.

**Table 4.** Descriptive measures of absolute latencies of waves I, III and V and interpeak I-III, III-IV and I-V (in ms) of BAEP in CG, SG1 and SG2.

		N	Median	Average	Standard Deviation	T Test		
						P-value		
						CGxSG1	CGxSG2	SG1xSG2
I	CG	28	1.52	1.56	0.307	0.25	0.96	0.28
	SG1	30	1.59	1.58	0.101			
	SG2	30	1.52	1.58	0.306			
III	CG	28	3.71	3.7	0.138	0.11	0.62	0.23
	SG1	30	3.79	3.8	0.218			
	SG2	30	3.73	3.72	0.161			
V	CG	28	5.68	5.68	0.133	0.88	0.62	0.59
	SG1	30	5.69	5.74	0.239			
	SG2	30	5.66	5.64	0.204			
I-III	CG	28	2.04	2.12	0.420	0.08	0.75	0.17
	SG1	30	2.2	2.14	0.216			
	SG2	30	2.07	2.14	0.425			
III-V	CG	28	1.97	2	0.056	0.03*	0.06	0.40
	SG1	30	1.9	1.88	0.16			
	SG2	30	1.93	1.92	0.102			
I-V	CG	28	3.94	4.06	0.782	0.31	0.96	0.27
	SG1	30	4.1	4.06	0.242			
	SG2	30	3.94	4.02	0.767			

**Legend:** \* statistical difference (p-value < 0.05).

For BAEP, in the analysis of qualitative data, no significant difference was observed between the groups. However, it points out that the three groups have showed changes (Table 1), suggesting that individuals with dizziness or vertigo disorder may show some change in BAEP, corroborating with some studies in the literature that demonstrate BAEP abnormalities in individuals with vertigo (3,9-13).

In the quantitative analysis of the BAEP, the CG and SG1 were different in relation to the interpeak III-V (Table 4). However, values are observed very close and within the normal range for both groups.

It is noteworthy that in this study, the etiology of dizziness or vertigo has not been established in all cases due to both the fact that individuals are still in the diagnostic process and the diversity of etiological factors (3,4,5), not always diagnosed. Further study of the etiology could help classify and understand better the changes found in the electrophysiological tests, since these seem to have a more central background (3:9-11).

In this sense, the idea that the auditory evoked potentials in association with the evaluation procedures are routinely used is reinforced and enables an integration of the information that can help reach a correct diagnosis, promoting more accurate results and a better evaluation of the system as a whole. The electrophysiological tests have

the benefit of not being invasive, being quickly and easily-applied, in addition to being used for the topographic diagnosis to monitor the development and treatment of various diseases impairing the encephalic structures.

Further studies are required to better characterize the AEP in peripheral and central vestibular syndromes, as well as to investigate the use of AEP to monitor the rehabilitation process of individuals with vestibular syndrome.

## CONCLUSION

Individuals with complaints of dizziness or vertigo may show changes in the BAEP, MLAEP and P300.

In comparison with individuals with dizziness or vertigo disorder and normal vestibular exam, PVS patients tend to have more MLAEP changes and those with DPVS also show changes in the P300.

It is noteworthy that the electrophysiological hearing tests provide an objective measure of the functioning of the auditory system, allowing more accurate results and better evaluation of the system as a whole, integrating information that might help in the differentiated diagnosis of vestibulopathies.

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