Estudo do efeito de supressão no potencial evocado auditivo de tronco encefálico*****

Study of suppression effect in the brainstem auditory evoked potential

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Abstract
Background: the suppression effect with contralateral white noise observed in the brainstem auditory evoked potential can be influenced by the efferent auditory system. Aim: to evaluate the suppression effect with contralateral white noise in the Brainstem Auditory Evoked Potential of individuals with normal hearing. Methods: 25 individuals, ranging in age from 18 to 30 years, of both genders, were submitted to a clinical history questionnaire, inspection of the external auditory canal, conventional audiometry, speech audiometry and acoustic immittance measurements. Only individuals with normal hearing thresholds were selected. The selected individuals underwent brainstem auditory evoked potential testing with and without contralateral white noise. Results: a significant statistical difference was observed between the situations with and without contralateral white noise, for wave I amplitude and waves III and V latencies. No statistical differences were observed for the interpeak latencies. Conclusions: the present study indicated increased latencies and reduced amplitudes of waves I, III and V with contralateral noise, when comparing the situations with and without noise. These results suggest a possible influence of the efferent auditory system on the response modulation of Brainstem auditory evoked potential when contralateral white noise is used.
Key Words: Auditory Evoked Potentials; Hearing; Evoked Potentials, Auditory, Brain Stem; Electrophysiology.

Resumo
Tema: o efeito de supressão com ruído branco contralateral verificado sobre o potencial evocado auditivo de tronco encefálico pode ter influência do sistema auditivo eferente. Objetivo: avaliar o efeito de supressão com ruído branco contralateral no potencial evocado auditivo de tronco encefálico em indivíduos com limiares auditivos dentro da normalidade. Método: participaram desta pesquisa 25 indivíduos, de 18 a 30 anos de idade, de ambos os sexos, que foram submetidos à anamnese, inspeção do meato acústico externo, audiometria tonal liminar, logoaudiometria e medidas de imitância acústica, com o objetivo de selecionar os indivíduos com acuidade auditiva normal. Em seguida os indivíduos selecionados realizaram o potencial evocado auditivo de tronco encefálico sem e com ruído branco contralateral. Resultados: na comparação entre as condições sem e com ruído branco contralateral verificou-se diferença estatisticamente significante para a amplitude da onda I e para as latências absolutas das ondas III e V, porém não foi observada diferença estatisticamente significante com relação às latências interpicos. Conclusões: o presente estudo verificou aumento nas latências e diminuição nas amplitudes das ondas I, III e V na presença de ruído contralateral, quando comparadas as condições com e sem ruído. Estes resultados sugerem uma possível influência do sistema nervoso auditivo eferente na modulação das respostas do potencial evocado auditivo de tronco encefálico quando se utiliza ruído branco contralateral.
Palavras-Chave: Potenciais Evocados Auditivos, Audição, Potenciais Evocados Auditivos do Tronco Encefálico; Eletrofisiologia.

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Introduction

The auditory evoked potential (AEP) is an objective method to assess the neuroelectrical activity of the auditory pathway - from the auditory nerve to the cerebral cortex - in response to an acoustic stimulus or event (1,2,3).

The AEP can be classified according to the latency period of responses - the time elapsed from the presentation of the stimulus up to the appearance of response (4). Thus, the AEP are classified as short, middle and long latency (2.3).

Among the short-latency AEP, there is the brainstem auditory evoked potential (BAEP). The BAEP is generated by synchronous firing of neurons in structures along the ascending auditory pathway including the auditory nerve, cochlear nuclei, superior olivary nucleus, lateral lemniscus and inferior colliculus (5,6,7,8).

The auditory system consists of ascending and descending auditory pathways that interact to each other in the processing of auditory information. The physiology of the ascending auditory pathway is well known and has been widely studied. However, the contribution of the corticofugal system (efferent) to the auditory processing has received little attention in the literature (9.10).

Recent studies have shown that the introduction of noise during the recording of evoked potentials can negatively affect the amplitude and / or the latencies of short, middle and / or long latency potentials (11,12,13). Investigating this matter, some authors (14) suggested that this effect of noise on the auditory evoked potentials could be mediated by the efferent auditory system.

Therefore, the purpose of this study was to analyze the effect of suppression with contralateral white noise on the brainstem auditory evoked potential in normal hearing individuals.

Methods

This study was designed and developed at the Laboratory of Auditory Evoked Potentials Investigation of the Speech Language and Hearing Sciences Program, Faculty of Medicine, University of Sao Paulo. The research was approved by the Ethics in Research - InCor, Hospital das Clinicas, under number 512/07.

Participants were 25 individuals from 18 to 30 years of age (mean age of 25.3 years old) of both genders. The individuals signed a consent form, in which the procedures to be performed were described, agreeing to their participation in the study.

The inclusion criteria for the sample composition were: no hearing impairment, no middle ear complaints, as well as hearing thresholds within normal limits.

First, in order to select individuals with normal hearing (i.e. hearing thresholds below 20 dB HL from 250 Hz to 8 kHz), participants were submitted to anamnesis, inspection of the external auditory canal, pure tone audiometry, speech audiometry and acoustic immittance measures.

Next, electrophysiological hearing assessment through BAEP was carried out in an electrically protected and acoustically isolated environment.

After cleaning the skin with abrasive paste, the electrodes were attached to the participants on vertex (Cz), forehead (Fpz), and right (M2) and left (M1) mastoid using electrolytic paste and adhesive tape. The impedance values of the electrodes were then verified. The impedance of the electrodes was found to be below 5 kOhms for every participant.

The acoustic stimulus used was the click of rarefaction polarity, presented monaurally through a pair of TDH 39 earphones at 70 dB HL. The presentation rate was of 19 clicks per second, duration of 0.1 milliseconds, totalizing 2000 stimuli.

The BAEP was performed twice, with and without contralateral white noise. The BAEP with inclusion of white noise was performed at the intensity of 60 dB.

The absolute latencies and amplitudes of waves I, III, V and the interpeaks I-III, III-V and -IV of BAEP, were analyzed in both conditions - with and without white noise. The results obtained in the BAEP with presence and absence of contralateral white noise were compared.

The paired t-student test was used for statistical analysis. The level of significance adopted was of 0.05 (5%).

Results

Initially, a comparison between the right and left ears in the condition without contralateral white noise was carried out. No statistically significant differences in absolute latencies of waves I (p-value = 0.373), III (p-value = 0.830) and V (p-value = 0.382); interpeaks I-III (p-value = 0.523), III-V (p-value = 0.524) and I-V (p-value = 0.841) as well for the amplitude values of waves I (p-value = 0.922), III (p-value = 0.223) and V (p-value = 0.479) were observed.

Regarding the condition with contralateral white noise, there were also no statistically significant differences when comparing the right and left ears for the absolute latencies of waves I (p-value = 0.826), III (p-value = 0.096) and V (p-value = 0.933); interpeaks I-III (p-value = 0.514), III-V (p-value = 0.171) and I-V (p-value = 0.909), and for the amplitude values of waves I (p-value = 0.366), III (p-value = 0.338) and V (p-value = 0.842).

Since no differences between the right and left ears in both BAEP conditions were observed, the values of latencies, interpeaks and amplitudes of both ears were considered for the following analysis.

When comparing the conditions with and without contralateral white noise, no statistically significant difference in the absolute latencies values of waves III and V were observed. In addition, a trend towards statistical significance for the latency of wave I (Table 1) was observed. In the comparison of interpeak latencies between the two conditions - with and without contralateral noise - no statistically significant difference was observed for any of the studied variables (Table 1).

Regarding the amplitude values, the difference was statistically significant only for wave I when comparing the two conditions of contralateral white noise (Table 2).

Figure 1 illustrates the pattern presented by the majority of tested ears with regard to latencies and amplitudes of waves I, III and V in the conditions with and without noise. In general, latency values of waves I, III and V were higher in the condition with noise when compared to the condition without noise, while the amplitude values were higher for the condition without noise when compared to the condition with noise. It may also be noted that the amplitudes presented greater dispersion variability when compared to the latencies for the three waves recorded.

TABLE 1. Mean, median, standard deviation and p-value of absolute latencies of waves I, III and V and interpeak latencies I-III, III-V and I-V with and without contralateral white noise.

Latencies	Wave I		Wave III		Wave V		I-III		III-V		I-V	
	Without	With	Without	With	Without	With	Without	With	Without	With	Without	With
Mean	1,61	1,64	3,74	3,79	2,13	2,16	1,86	1,86	3,98	4,02	5,60	5,65
Median	1,60	1,64	3,72	3,76	2,12	2,16	1,84	1,84	3,98	4,00	5,56	5,64
Standard Deviation	0,15	0,13	0,17	0,21	0,20	0,24	0,15	0,18	0,22	0,21	0,17	0,18
Minimum	1,16	1,24	3,32	3,32	1,72	1,64	1,56	1,32	3,52	3,64	5,24	5,32
Maximum	2,00	2,00	4,08	4,68	2,92	3,28	2,24	2,52	4,60	4,60	5,96	6,08
ample size	50	50	50	50	50	50	50	50	50	50	50	50
p-value	0,072#		0,003*		0,009*		0,170		0,976		0,172	

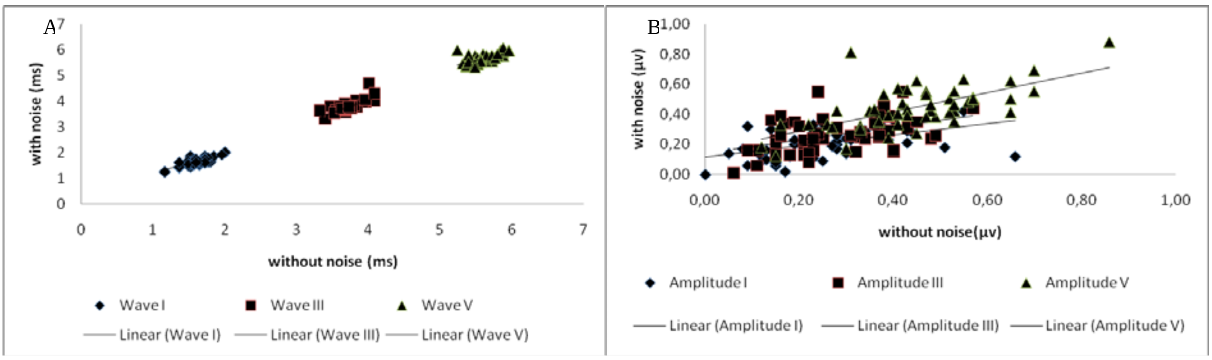
Note: * - p-value statistically significant; # p-value with a trend to significance. Paired t-Student test.

TABLE 2. Mean, median, standard deviation and p-value of amplitude of waves I, III and V with and without contralateral white noise.

Amplitude	Wave I		Wave III		Wave V	
	Without	With	Without	With	Without	With
Mean	0,26	0,21	0,28	0,26	0,45	0,44
Median	0,25	0,21	0,25	0,26	0,45	0,43
Standard Deviation	0,13	0,10	0,12	0,11	0,15	0,15
Minimum	0,00	0,00	0,06	0,01	0,12	0,12
Maximum	0,66	0,43	0,57	0,55	0,86	0,88
Sample Size	50	50	50	50	50	50
p-value	0,010*		0,384		0,917	

Note: * - p-value statistically significant; Paired t-Student test.

FIGURE 1. Dispersion graphs of latency values (A) and amplitude (B) of waves I, III and V in the conditions with and without noise.



Discussion

Studies with animals show that the efferent auditory system begins in the auditory cortex, projecting to the medial geniculate body, inferior colliculus and auditory sub-collicular. Corticothalamic fibers project only to the medial geniculate body and to the ipsilateral thalamic reticular nucleus. However, corticocollicular fibers project bilaterally to the inferior colliculus. Corticofugal projections are bilateral to the sub-collicular nuclei (9).

Corticofugal modulation has participation even in the cochlea via the olivocochlear neurons that start at the superior olivary complex. The central nucleus of the inferior colliculus is projected not only to the medial geniculate body, but also to medial olivocochlear neurons, which, in turn, are mainly projected to the ipsilateral and contralateral outer hair cells (9). Thus, the structures assessed by BAEP receive innervation of the efferent corticofugal system and could be influenced by the modulation of this system when necessary.

The presence of broadband noise can cause a decrease in electrical activity of afferent neurons because it induces an adaptive masking in primary afferents, reducing the firing rates evoked by an additional stimulus (in this case the BAEP click) and increasing the latency of responses (10).

In addition, the broadband noise can reduce the phase synchronization of the primary afferent to an additional stimulus, reducing the amplitude of response to this stimulus. It can also activate the efferent neurons that would cause some suppression of afferent responses (10) as it was observed in this study - increased latencies (statistically significant for waves III and V, and a trend towards significance for the wave I) and decreased amplitude (statistically significant for wave I) were observed in the condition with contralateral white noise as compared to the condition without noise.

Such noise effect on the BAEP wave(s) has already been observed in previous studies however, with smaller magnitude. This difference can be explained by the different applied parameters. Some authors (15) used ipsilateral broadband noise and found that noise levels equal to or greater than 20 dB of effective masking caused an increase in latency and a decrease in amplitude of wave V, according to the increasing noise level.

In turn, another study (16) found significant prolongation of waves III and V with contralateral white noise at 90 dB HL and click at 70 dB HL. For noise intensity at 80 dB HL, a significant increase was observed only for wave V. Below this intensity no latency alteration was observed for any of the waves. Based on these findings, the authors concluded that the presence of contralateral white noise at intensity levels below 80 dB HL did not affect the responses of BAEP and suggested that the observed effect on the waves would be influenced by the central masking.

Increased latency and decreased amplitude of wave V, for individuals with normal hearing and for individuals with hearing loss have been reported when effective ipsilateral broadband masking was applied (17). Similar results, also using continuous ipsilateral broadband noise, were obtained in another study, in which a slight change in wave I, but a significant change to the latency of wave V was observed (18).

In a study using contralateral noise, no significant change in wave V was observed. However, significant change was observed in the middle latency component of Pb. The authors reported that, with the use of contralateral noise, unlike previous research that used ipsilateral noise, the observed effects could not be attributed only to ipsilateral cochlear events or brainstem. In contrary, the effects would be influenced by central mechanisms, although such physiological mechanisms are not yet known (12).

The results of the study mentioned above (12) are consistent with the findings of a prior investigation (19), in which the effect of ipsilateral and contralateral noise on wave V of BAEP and on the Auditory Steady State Evoked Potentials (ASSEP) at 40 Hz was analyzed. The authors found no change in wave V, but verified a decreased in the amplitude of ASSEP. They concluded that the observed effects were of central origin because the ASSEP are generated primarily in the auditory cortex (19).

The two previously mentioned studies (12, 19), although they have not yet been replicated with regard to wave V of BAEP, suggest a central origin for the effects of noise on the AEP. This indicates the need for further studies, which could clarify the influence of the efferent system in conditions with contralateral noise, resulting in a possible suppressive effect also for the middle and long latency potentials.

In the investigation of the masking effect on N1 and P2 waves (14), it was evidenced that the presence of broadband noise can significantly alter the amplitudes of the waves - with N1 amplitude attenuation and P2 amplitude increase being observed. The authors suggested that this effect could be mediated by the efferent system, as it occurs in cases where the activation of the olivocochlear auditory efferent system attenuates the otoacoustic emissions with the application of contralateral noise (14).

Investigating the Middle Latency Auditory Evoked Potential with click stimulus and contralateral music in normal hearing adults (20), a decrease in wave amplitudes of the ear contralateral to the music stimulus in all electrode positions and for all subjects was reported - although this difference was not statistically significant. Although having stated that further studies are needed, the authors agreed to the hypothesis stated by the previously mentioned study (14) that this effect could be influenced by the efferent system.

Conclusion

In the present study, increase in latencies and decrease in amplitudes of waves I, III and V in the presence of contralateral noise was observed when compared to the condition without noise. These results may suggest the influence of the efferent auditory system in modulating BAEP responses when contralateral white noise is applied.

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