BRAINSTEM AUDITORY EVOKED POTENTIAL IN SUBJECTS WITH SENSORINEURAL HEARING LOSSES

Potencial evocado auditivo de tronco encefálico por via óssea em indivíduos com perda auditiva sensorioneural

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ABSTRACT

Purpose: to characterize the results of ABR via bone in subjects with mild sensorineural hearing loss, comparing these data with the control group made up by subjects with normal hearing. **Method:** the sample consisted of 40 adults of both genders, 18 – 55 year old, divided into a control group of 30 subjects with normal hearing and a study group made up of 10 subjects with mild sensorineural hearing loss. ABR was carried out with Interacoustics brand EP15. The stimulus was the click presentation rate of 27.7 / s, for a total of 2000 stimuli with rarefaction polarity for AC and switched to VO and band-pass filter of 50Hz and 3000Hz. **Results:** in subjects with mild sensorineural loss, there were no statistically significant differences between the ABR threshold via air and bone, and those thresholds were equivalent, with air-bone gap of less than 10dB. The latencies of wave V in the electrophysiological threshold and 50 dBnNA were lower latencies than those noted in subjects with normal hearing. **Conclusion:** we found electrophysiological thresholds via bone equivalent to thresholds obtained via air, with the presence of air-bone gap being less than 10dBnNA. Thus, the use of VO by ABR provides data for a more-detailed characterization of the type of hearing loss.

KEYWORDS: Hearing; Electrophysiology; Hearing Loss

INTRODUCTION

The auditory system is responsible for the sensation and the perception of sound stimuli, allowing the human being to detect different sounds at the same time, consisting of sensory structures and central connections, having the respective roles of stimulus capture and auditory processing [1].

The integrity of the auditory system, from the capture of the acoustic signal by the outer ear to the coding in the cortex, reflects the normal development of language and intellect, being one of the main means of human contact with the outside world [2]. Any change in these organs results in the restriction of the abilities to communicate through spoken language [3.4].

Hearing loss is any change in the peripheral or central auditory system which causes a partial or total reduction of the auditory acuity [5], characterized according to the local involvement, and thus it can be classified as conductive hearing loss (which affects the middle ear and external ear), sensorineural hearing loss (affecting inner ear and/or nerve), mixed hearing loss (affecting both middle ear and inner ear) and central hearing loss (changing the central nervous system) [6].

The type of hearing loss can be determined by using the following techniques: pure tone audiometry and evoked auditory brainstem response (ABR) [1].

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The auditory brainstem response is an objective test and noninvasive evaluation of the electrophysiological activity from the auditory system to the brainstem in response to acoustic stimulation [7-10]. This technique can be characterized as short latency potential, which evaluates the integrity of the auditory pathway in response to an acoustic signal characterized by a quick onset and short duration, presenting bioelectric responses which result from the successive activation of the cochlea and nerve fibers of this pathway [11-13].

The ABR response comes in the form of seven waves that appear between zero and 12 ms after the acoustic stimulation, which was obtained by means of surface electrodes to record the electrical activity[14-16]. These waves represent the structures of the auditory pathway having the following generators sites: wave I – distal portion of the cochlear nerve, wave II – proximal portion of the cochlear nerve, wave III – generated in the cochlear nucleus, wave IV: superior olivary complex; wave V: lemniscus side; wave VI: inferior colliculus; wave VII: medial geniculate body[17,18].

The analysis of the ABR not only occurs through the absolute latencies of waves I, III and V, but also considers the values of interpeak latency, which is the time interval between waves [15, 19-22].

The main clinical application of ABR is the differential diagnosis between cochlear and retrocochlear alterations. Among the other clinical applications of this technique one could point out the evaluation of patients who are difficult to test, to characterize the type of loss and to determine the minimum level of auditory response [15, 23-26].

The moderate grade sensory hearing losses (cochlear) show as results the presence of waves with absolute latencies and normal interpeak in the brainstem's auditory evoked potential (BAEP) by AC [17], while in the tonal audiometry it is observed changes in the thresholds by air conduction (AC) and bone conduction (BC), with air-bone GAP equal or less than 10dB [6].

According to research conducted in sensorineural hearing loss from mild to moderate in the high frequency responses of the ABR may present similar to the curves obtained in subjects with normal hearing[27].

However, the ABR can be accomplished either by AC as BC. So when evaluating a person who provides inconsistent and/or unreliable answers by tonal audiometry [28.29], it is recommended to use the BAEP by AC in order to predict the thresholds reliably [23]. However to get an altered BAEP by AC, there is the need for BAEP by BC testing in order to analyze the presence of GAP and determine the type of hearing loss.

Due to the scarcity of studies in the literature analyzing the responses of ABR by bone conduction in hearing loss and the importance of this exam to audiological diagnosis, it is necessary to develop more studies in order to determine their characteristic findings.

Currently, the ABR by air conduction is the most used technique to predict pure-tone thresholds; however, the ABR by bone conduction is another feature that can help in the audiology diagnostic to characterize hearing loss. Given the above, the general objective of this study was to characterize the results of ABR by bone conduction in individuals with sensorineural hearing loss, comparing the responses of the study group with aurally normal individuals.

METHOD

This research is aligned with a master dissertation[30] and was developed at the Otolaryngology and Phonoaudiology Clinic in Alagoas – Otoclinic, being an observational transversal study.

The sample consisted of 40 adults of both genders, aged from 18 to 55 years old, divided into a control group of 30 subjects with normal hearing and a study group of 10 individuals with mild sensorineural hearing loss. Individuals with sensorineural hearing loss which presented characteristics of retrocochlear change during BAER testing were excluded, being considered the following results to characterize the amendment change: increased of latency of waves III and/or V with increasing values of interpeak interval I-III and/or IV and/or III-V; lack of incompatible waves with behavioral thresholds, presence of only wave I.

Before starting the procedures, participants signed an informed consent form.

Initially we applied an anamnese interview in order to identify the conditions and/or hearing complaints from participants. Then otoscopy was performed to rule out the presence of cerumen or change in the external auditory canal.

Pure tone audiometry was performed in a soundproof booth, through the Wellch Allyn GSI 61 audiometer with TDH 39 earphone. We searched the pure tone thresholds at 0.25 Hz to 8 kHz by air conduction (AC) and 0.5 Hz to 4 kHz by bone conduction.

The ABR was carried out with an equipment of the model EP15, brand Interacoustics. First, there was performed a cleansing of the skin with abrasive paw, and the electrodes were attached to the skin on the vertex position, the jaw region and the right and left mastoid following the 10-20 International System. The values of electrode impedance, which should be around 5Kohms and the inter-electrode impedance, which should be less than 3Kohms, were checked.

The stimulus used in ABR by AC and BC was the click presentation rate of 27.7/s, in a total of 2000 stimuli in rarefaction polarity for AC and altered for VO and band-pass filter of 50Hz and 3000Hz . For BAEP by AC recordings, EARTONE 3A (ER3A) insert earphones were used and initial intensity of 80 dBHL, being observed in the answers of the absolute latencies of waves I, III and V, and interpeak I-III, III-V and IV as well as the presence of the V wave in the last recorded intensity. In the BAEP by BC registry a B-71 bone vibrator with pressure/force which ranged between 300 and 350 grams was used and initial intensity of 50 dBHL, for the maximum intensity by bone conduction of the equipment (60dBnNA) caused interference, making the observation of wave V difficult. The test was performed with the use of contralateral masking. In bone conduction, it was examined only the presence of wave V, since the waves I and III are less frequent due to the initial intensity be 50dBnNA.

It was analyzed, the results of bone conduction considering electrophysiological threshold, wave V latency at 50dBnNA and the wave V latency at the threshold, in addttion it was also compared the ABR thresholds by bone and air conduction to verify the ~~a~~ similarities between them. It is important to point out that the wave V was the only one considered to be the most frequent in BAEP by BC.

This research follows the Resolution 196/96 which deals with human research and was forwarded and approved by the Research Ethics Committee (REC) from UNCISAL with protocol number 1051, as well as by the CEP of the Federal University of São Paulo (UNIFESP), with protocol number 0301/09.

It was used nonparametric tests and statistical techniques, because the conditions (assumptions) for the use of parametric tests and techniques, such as normality (Anderson-Darling test, normality distribution graph, acronym AD) and homoscedasticity (homogeneity of variances , Levene's test), were not found (mainly the normality) in this dataset. However, the Wilcoxon test was used to verify whether there is a significant difference between the studied variables.

It was considered for this study a significance level of 0.05 (5%). All confidence intervals constructed throughout the work were 95% statistical confidence. In this analysis, it was used as statistical software: SPSS V16, Minitab 15 and Office Excel 2007. All results were stored on a HP 3000laptop, 512MB of RAM, for archiving and later printing

RESULTS

ABR by BC responses from subjects with mild sensorineural hearing loss were characterized by the absolute latency of wave V and electrophysiological threshold. These data were compared with the results of ABR by BC from subjects with normal hearing and with BAEP by AC, which are presented below.

The average ABR thresholds (in dBHL) by air and bone conduction, in the group of subjects with mild sensorineural hearing loss, are presented in Table 1. The comparison of these results shows no significant difference, although bone thresholds are slightly worse than the air ones.

Table 1 – Average ABR thresholds by air and bone conduction in subjects with mild sensorineural hearing loss

	Average	SD	Mediana	Q1	Q3	n	CI	
AC	37,5	9,7	40	30	40	20	4,2	*p*=0,166
BC	40	10,6	40	30	50	20	4,5	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.166

As an individual with mild sensorineural hearing loss showed no response to 50 dBHL, the sample from tables 2 and 3 were reduced from 10 to 9 individuals.

Comparing the latencies of wave V in the average ABR thresholds (in dBHL) by bone conduction, in the group of individuals with mild sensorineural hearing loss, according to the variable side of the ear, it is observed in Table 2, that there was no statistical significant difference.

In Table 3, it is found the average values of wave V latencies (in ms) obtained by the 50dBnNA bone in individuals with sensorineural hearing loss, according to the variable side of the ear, with no statistically significant difference.

Comparing the average ABR thresholds by air and bone conduction (in dBHL), in the group of subjects with normal hearing (Table 4), there was a statistically significant difference between the ABR thresholds by air (19.5 dB) and bone (17.3 dB), with lower thresholds obtained by bone conduction. However when comparing these values with Table 1, it is possible to observe an air-bone GAP of 2.2 dB in normal subjects (Table 4) and the presence of air-bone GAP of 2.5 dB in subjects with mild sensorineural hearing loss (Table 1). These differences are not considered pathological GAP, being compatible with the absence of conductive impairment.

Table 2 – Latencies of wave V in the ABR by BC threshold in subjects with mild sensorineural hearing loss according to variable of the ear side

	Average	SD	Median	Q1	Q3	n	CI	
Right Ear	7,51	0,51	7,63	7,23	7,83	9	7,51	*p*=0,82
Left Ear	7,32	0,85	7,63	7,1	7,83	9	7,32	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.82

Table 3 – Average values of wave V latencies (in ms) at 50dBNA obtained by bone conduction in individuals with mild sensorineural hearing loss according to the variable of the ear side

	Average	SD	Median	Q1	Q3	n	CI	
Right Ear	6,81	0,49	6,6	6,53	6,9	9	6,81	*p*=0,65
Left Ear	6,69	0,32	6,7	6,43	6,97	9	6,69	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.65

Table 4 – Average thresholds of ABR by air and bone conduction in subjects with normal hearing

	Average	SD	Median	Q1	Q3	n	CI	
AC	19,5	5	20	20	20	60	1,3	*p*=0,007*
BC	17,3	5,8	20	10	20	60	1,5	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.007

It is shown in Table 5, the results of the values of wave V latencies at 50dBnNA (in ms) obtained by bone conduction, in individuals with normal hearing, over the ear side variable. Considering the statistical study done, it was not observed a statistically significant difference. However in the comparison of these results with the study group (Table 3), it is noted that the values obtained in normal hearing individuals were higher than the results in the group with mild sensorineural hearing loss.

Table 6 shows the average values of wave V latencies (in ms) on the threshold obtained by bone conduction, in individuals with normal hearing, over the ear side variable. However, it does not demonstrate a statistically significant difference between the variable.

Table 5 – Average values of wave V latencies (in ms) at 50dBNA obtained by bone conduction in individuals with normal hearing regarding the variable ear

	Average	SD	Median	Q1	Q3	n	CI	
Right Ear	6,82	0,41	6,7	6,5	7,0	30	0,15	*p*=0,263
Left Ear	6,90	0,58	6,8	6,6	7,0	30	0,21	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.263

Table 6 – Average values of wave V latencies (in ms) on the threshold obtained by bone conduction in individuals with normal hearing, according to the variable of the ear side

	Average	SD	Median	Q1	Q3	n	CI	
Right Ear	8,47	0,49	8,5	8,2	8,8	30	0,18	*p*=0,198
Left Ear	8,50	0,70	8,6	8,2	8,9	30	0,25	

Legend: CI (confidence interval), SD (standard deviation), n (number of individuals), Q1 (25% of sample); Q3 (75% of the sample). Wilcoxon test, p = 0.198

DISCUSSION

The threshold of ABR in subjects with mild sensorineural loss (Table 1) was lower by air conduction (37.5 dBHL) than by bone conduction (40 dBHL), and no statistically significant difference was observed as reported in the literature [31-35]. Thus, it was found that in the studied population the GAP between the ABR thresholds by air conduction and by bone conduction was 2.5 dBHL. This confirms the equivalence between the results of electrophysiological thresholds for AC and BC, and is compatible with the characteristic findings of tonal audiometry in this type of loss[6].

When there is no response, as occurred in the sample from tables 2 and 3, it is recommended to use the maximum intensity of the equipment as the threshold; however it is not possible to determine the latency. This justifies the reduction to nine in the number of participants.

According to Table 2, the latency of wave V by bone conduction in electrophysiological thresholds in individuals with mild sensorineural hearing loss in the right ear was 7.51 ms and 7.32 ms for the left ear, presenting no statistically significant difference . No studies were found describing the latencies of wave V of ABR by BC according to the side of the ear in sensorineural hearing loss. However, by comparing the results to other studies that showed proximity to the subject of the research, there was disagreement in the study that relates the wave V latency in electrophysiological threshold in normal hearing individuals around 8.5 MS[32]. It was also observed a latency disagreement with another study that evaluated subjects with normal hearing and those with conductive hearing loss, getting a response equal to 8.34 ms for the two groups [36]. This fact of disagreement can be explained by the recruitment of individuals in our study, justifying the wave V latencies lower in subjects with mild sensorineural hearing loss [37].

In Table 3, there was no statistically significant difference between the ears to the latency values of wave V at 50dBnNA. However, it was found that the latency in the study group (OD = OE = 6.81 ms and 6.69 ms) was equivalent to the value obtained in normal hearing subjects (OD = OE = 6.82 ms and 6.90 ms), agreeing with another study that compared the latencies of ABR by AC among individuals with sensorineural hearing loss and people with normal hearing[38]. This finding strengthens the justification that the recruitment influences the BAER responses.

The findings of this study showed in table 4 that there was a statistically significant difference between the average ABR thresholds for AC and BC in individuals with normal hearing, similar to the consulted studies [31.32]. However ABR thresholds obtained by bone conduction were smaller than ABR thresholds by air conduction, with 17.3 dBHL and 19.5 dBHL respectively, which corroborates the findings of the literature [35]. These data are consistent with the results of pure tone audiometry, which considers as normal hearing thresholds up to 20dB HL [6].

The latency of wave V at 50dBnNA in the ABR by AC in subjects with normal hearing, presented in the right ear (RE) average values of 6.82 ms and the left ear (LE) of 6.90 ms, not having statistically significant difference between these findings, as shown in Table 5. However, the latency values obtained agree with research that showed similar results of approximately 6.8 ms [32,35,36].

In the present study it was not found either statistically significant differences in the variable part of the ear to the latency of wave V at the threshold obtained by BC (Table 6). These data corroborate several authors, who suggest that the assets acquired in the ABR by air conduction to the right and left ear are similar [7,39,40]. Thus, it is not expected latency differences between the evaluated sides.

CONCLUSION

Therefore, the use of BAEP by BC provides data for a more detailed characterization of the type of hearing loss.

RESUMO

Objetivo: caracterizar os resultados do PEATE por via óssea em indivíduos com perda auditiva sensorioneural leve, comparando esses dados com o grupo controle, formado por indivíduos audiologicamente normais. **Método:** a amostra foi constituída por 40 adultos, de ambos os sexos, com faixa etária de 18 a 55 anos, distribuídos em um grupo controle de 30 indivíduos com audição normal e um grupo estudo composto de 10 indivíduos com perda auditiva sensorioneural de grau leve. O PEATE foi realizado com equipamento EP15, da marca Interacoustics. O estímulo utilizado foi o clique com taxa de apresentação de 27,7/s, em um total de 2000 estímulos, com polaridade de rarefação por VA e alternada para VO e filtro passa-banda de 50Hz e 3000Hz. **Resultados:** em indivíduos com perda sensorioneural de grau leve, não houve diferenças estatisticamente significantes entre o limiar do PEATE por via aérea e óssea, estando esses limiares equivalentes, com GAP aéreo-ósseo menor que 10dB. A latência da onda V no limiar eletrofisiológico e a 50 dBnNA foram menores que as referidas latências observadas em indivíduos com audição normal. **Conclusão:** foram encontrados limiares eletrofisiológicos por via óssea equivalente aos limiares obtidos por via aérea, com presença de GAP aéreo-ósseo menor que 10dBnNA. Assim a utilização do PEATE por VO fornece dados para uma caracterização mais detalhada do tipo da perda auditiva.

DESCRITORES: Audição; Eletrofisiologia; Perda Auditiva

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