Electrophysiological Evaluation of the Auditory Nerve in Normal Hearing Patients with Absence of Stapedial Reflexes

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SUMMARY

Introduction: The stapedial reflex is a stapedial muscle contraction located in the middle ear, induced by an intense acoustic stimulus. It is expected that individuals with auditory thresholds within the normality standards have stapedial reflexes once there is integrity of the middle ear. However, the existence of normal hearing persons, with absence of stapedial reflex, has been observed, which may suggest the absence of the stapedial muscle or even the alteration of the auditory nerve (neuropathy). The AEP (Encephalic Trunk Audition Evoked Potential) is an objective and complimentary exam of hearing that evaluates the functioning of the cochleovestibular nerve.

Objective: This study was carried out aiming to review the auditory nerve electrophysiological evaluation findings, through AEP, in normal hearing patients without auditory complaints and with absence of the stapedial reflex, confirmed by imitanciometry.

Method: We studied 68 individuals of both sexes and aged from 18 to 30 years without auditory complaints. The procedures carried out comprised anamnesis, internal acoustic meatus inspection, threshold tonal audiometry, logoaudiometry, imitanciometry and AEP.

Results: The AEP exams of the population sample showed outcomes within the normality standard with presence of wave I, III and V, with absolute latency values and interpeaks within the normality standards, which suggested integrity of the central auditory passages.

Conclusion: The absence of stapedial reflexes in normal hearing patients, without auditory complaint is not sufficient by itself to diagnose the existence of auditory neuropathy and requires application of the AEP exam.

Keywords: electrophysiology, auditory diagnosis, stapedial reflex, auditory neuropathy.

Introduction

The auditory function is essential for contribution for the complex system of human communication. Therefore, any alteration of the auditory perception may lead to problems in the development of speech, language, reading, learning and even the socialization of children, adults and elderly.

Because of such importance, there are several subjects studied about hearing, its alterations, its habilitation and rehabilitation.

As from 1995, the term auditory neuropathy has been used to define groups of auditory alterations from the results of complimentary exams in the evaluation of hearing that relates to the alteration characterized by a failure in obtaining the evoked auditory potentials of the encephalic trunk and the presence of otoacoustic emission within the normality parameters.

The auditory neuropathy consists of affection of the auditory nerve that generates a desynchrony in the nervous conduction, probably related to these fibers myelinization changes. The precise site of alteration is not defined and may differ in the several cases, but it is probably in the inner hair cells, in the synapses between inner hair cells and the VIII pair, in the VIII pair itself, or even in several of these structures.

These patients may clinically present with normal hearing, prelingual or postlingual loss, of several different levels up to full deafness, generally with an auditory discrimination incompatible with the tonal threshold.

The encephalic trunk audition evoked potential may show alterations as from wave I, present even with not much altered tonal thresholds. Such neural commitment is also confirmed by the absence of the stapedial reflex and the medial olivocochlear reflex.

Hearing is the sense that promotes the human communication and develops the speech and the language of mankind.

The auditory system peripheral evaluation is understood by the Threshold Tonal Audiometry (TTA), Logoaudiometry, Imitanciometry, Otoacoustic Emissions (OAE), Electrocochleography (EcochG) and Encephalic Trunk Audition Evoked Potential (AEP).

The Threshold Tonal Audiometry (TTA) is taken as a subjective evaluation of hearing that evaluates the auditory system integrity in a quantitative manner, and offers information as for the type and degree of the hearing loss. The evaluation is composed by the airway research (sound conduction by means of headphones) osseous way (sound conduction by osseous vibrator) and carried out by means of an Audiometer and an Acoustic Cabin, both duly calibrated.

The logoaudiometry, considered to be a subjective evaluation, is defined by the capacity to evaluate the human speech understanding, carried out through lists of words, Audiometer and Acoustic Cabin.

The Imitanciometry is an objective test that does not need response from the patient and enables the verification of the state of the middle ear. It is composed by two stages: tympanometry and research of the stapedial reflex. Tympanometry corresponds to the measurement of the middle ear pressure, obtained through admittance (facilitation for acoustic signs transmission) or impedance (opposition to acoustic signs transmission) of the tympano-ossicular system, featuring the tympanometric curves. The stapedial reflex would have the function of protecting the cochlea from intense sounds, and when the reflex path was expelled, the stapedial muscle of both ears would contract, by hardening the ossicular chain, and leading to a change to the immittance. This path is composed by the cochlea, VIII cranial nerve, ventral cochlear nucleus, upper olivary complex, facial motor nucleus and facial nerve's motor branch. The absence of the acoustic reflex could mean a hearing loss of intense degree enough to inhibit it, indicate that the middle ear would present alteration or that there would be a lesion in the reflex path (1).

The OAEs defined as sounds found in the external auditory meatus resulting from the cochlear physiological activity associated to the hearing process are characterized by an energy from the moving of the cochlea external hair cells, whose energy moves opposite to the system and may be captured in the external auditory meatus by means of a microphone, according to Kemp (1997). Therefore, the OAEs would be considered to be an objective evaluation of the auditory system, since their findings would not rely on the patient's response (2,3).

Other objective tests can be carried out in addition to the OAEs, amongst which the electrophysiological evaluation of the auditory nerve, comprising the research by the Encephalic Trunk Audition Evoked Potential (AEP). This research evaluates the integrity of the auditory way since the auditory nerve up to the encephalic trunk, which occurs during the first milliseconds as from the acoustic stimulation. The same authors reported that the AEP would be composed by seven waves, and waves I, III and V are the most visible. As for the sites generating these waves, the mostly accepted classification today would be se

following: I - Distal portion to the encephalic trunk of the auditory nerve; II - proximal portion to the encephalic trunk of the auditory nerve; III - cochlear nucleus; IV - upper olivary complex; V - lateral lemniscus; VI - inferior colliculus and VII - medial geniculate body (4).

The encephalic trunk audition evoked potential (AEP) has been largely used as a method for evaluation of the cochlear function in individuals with diagnosis of auditory neuropathy. In the absence of the otoacoustic emissions, several cases of auditory neuropathy were diagnosed by the presence of cochlear microphonism identified in the AEP (5).

The technological advances have led to an increase of diagnosis resources and intervention in the cases of Auditory Neuropathy (6).

The stapedial reflex latency research is a clinical procedure that tells cochlear and retrocochlear origin lesions and may be performed by means of Imitanciometry.

Because of the high intensity acoustic stimulus, the acoustic reflex, that is to say, the contraction of the middle ear muscles, has been considered to be an important diagnostic tool in the clinical evaluation of hearing, for it supplies data regarding the functioning of the middle ear and the auditory paths at the basis of the Central Nervous Auditory System (7).

The knowledge of anatomy and physiology of the stapedial reflex is critical for the interpretation of the auditory tests findings.

The acoustic reflex test is taken as an important tool for the diagnosis of the central auditory nervous system disorders and provides functional measurements of the structures found in the encephalic trunk because of the reflex-arc involvement with the neural activities of their auditory nuclei. These nuclei also perform activities involved in the Auditory Processing (AP) and it would be possible that a dysfunction could lead to alterations of the stapedial acoustic reflex and be present in increased intensity levels, with thresholds higher than 90 dBSL - Sensation Level Decibel, absent in some frequencies, and also present failures in the AP-related abilities, such as location, selective attention, speech recognition in noise, frequency selectivity (8).

The absence of contralateral stapedial reflex without justification has been frequently verified in the clinical practice. Such finding upon performance of the Imitanciometry drew the attention of audiologists (9).

This study was carried out aiming to review the auditory nerve electrophysiological evaluation findings, through AEP, in normal hearing patients without auditory complaints and with absence of the stapedial reflex, verified by imitanciometry.

Method

This transversal study began after approval of the Ethics Committee in Research of the Medical School Dr. Domingos Leonardo Cerávolo, of the Ethics Committee in Research of the Universidade do Oeste Paulista of Presidente Prudente - SP (UNOESTE) and of the Research Committee of Unoeste, in May 2008.

The research was accomplished by the Institute of Audiology of the Medical School Dr. Domingos Leonardo Cerávolo, bound institutionally to the Phonoaudiology School of Presidente Prudente, of the Universidade do Oeste Paulista.

Prior to the data collection, the individual to be researched received a Free and Clarified Authorization Term (TCLE) (Annex I) and after signing it, the testing procedures took place. The TCLE was prepared in two counterparts, one for the researcher and the other to the research participant, in a single page. The TCLE was dated and signed by both parts and filed by the researchers.

The population sample comprised 68 individuals in the age range from 18 to 30 years old, male and female sex, selected in the Phonoaudiology Clinical School. Only those who presented hearing within the normality standard and absence of stapedial reflex were included for the continuity of the research, confirmed by the Threshold Tonal Audiometry and Imitanciometry. Only after this first evaluation and results, the Encephalic Trunk Audition Evoked Potential exam (AEP) was carried out.

For composition of the sample, the following criteria were set up: auditory thresholds up to 20 dBHL (Hearing Level Decibel) in the frequencies of 250 to 8000 Hz; speech recognition threshold compatible with the auditory thresholds average; speech recognition rate above 88% for monosyllabic words; type A tympanometric curve, characterized by the static complacency between 0.3 to 1.3 ml (milliliters); absence of the contralateral stapedial reflex in the ear tested for frequencies from 500 to 4000 Hz.

The procedures performed comprised:

1. Anamnesis: Initial interview that was made through a close set questionnaire, whose data collected involved the patient's identification, complaint, complaint

Annex I.

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Faculdade de Fonoaudiologia de Presidente Prudente - Unoeste.
Free and Clarified Authorization Term:

The study "Electrophysiological Evaluation of the Auditory Nerve in Normal Hearing Patients with Absence of Acoustic Reflex", approved by the Ethics Committees in Research of the Hospital Universitário Dr. Domingos Leonardo Cerávolo and the Universidade do Oeste Paulista, is intended to analyze the functioning of the nerve responsible for hearing, in people from 18 to 30 years of age, without auditory complaints.

The exams to be carried out are not invasive, do not cause any discomfort or pain and will be carried out by skilled professionals. They comprise audition evaluation, by means of sounds, like whistle, human voice and rain noise. The patient will be provided with the report for each test, followed by the original test accomplished. In case of any alteration of hearing there will be forwarding to otorhinolaryngologist. Any doubt concerning the study, procedures, results and/or subjects regarding the research may be clarified at any time.

The researchers in charge of the study, as well as the data collection are the academy of Phonoaudiology Keiny Sander A. Pinotti and professors Patrícia Arruda de Souza Alcarás and Maria Cristina Alves Corazza, who may be contacted on the phone numbers (18) 3229-1125 and/or the address R: José Bongiovani, 700 Bl-H, Clínica Escola de Fonoaudiologia. Other information may be obtained in the Institutional Ethics Committee, with Dr. Rosa Barilli (18) 32292077/32292078.

In case of waiver of participation in the research, there will be no penalty or burden. There is no form of remuneration for participation. The identity of the research individuals will be maintained absolutely confidential and the results published by means of specialized literature, papers, magazines and others and/or in congresses and scientific events in the area.

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I, _____bearer of the identity card no. _____SSP-____, state to be aware and agree with the terms for the accomplishment of this study, and I was informed about all procedures of audition evaluation to which I will be submitted. My identity will be held confidential. I voluntarily agree to take part of this study and may withdraw my authorization at any time, before or during its accomplishment without penalties or burdens. I am fully aware of the absence of remuneration for the participation in the aforesaid study. Truthfully yours

_____
Signature of the participant in the study.

Presidente Prudente, _____ _____ 2008.

specification, current record of the overall health, previous history of the general health and current habits, standard protocol of the H.U. Audiology (Annex II).

2. Evaluation of the External Acoustic Meatus: comprised the verification of the external auditory meatus integrity, aiming to discard the presence of foreign bodies or the existence of excessive earwax that could commit the performance of the tests proposed. As the base material we used the HEIDJI Otoscope.
3. Threshold Tonal Audiometry: basic evaluation of audition was carried out, in which the patient was positioned in a cabin acoustically treated under norm ISO 8253.1, and through sound stimuli of pure tone per airway emitted by the TDH-39 phone we researched the hearing thresholds with the descending technique proposed by KATZ (1999) in the following stimuli presentation order: 1000, 2000, 3000, 4000, 6000, 8000, 500 and 250 Hz. As base material we used the AC-40 Audiometer, of Interacoustic trademark with TDH-39 phones and

Annex II.

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Anamnesis:
No. Identification____
Name:_____
Age:_____ DN:____/____/____ Sex ( ) F ( ) M
Occupation (current and previous):_____
Complaint:_____
_____
Since:_____
Tinnitus ( ) yes ( ) no Typo: _____
Dizziness ( ) yes ( ) no Rotative ( ) yes ( ) no
Current and prior noise exposure:_____
_____
Leisure habits / Social Demand:_____
_____

Antecedents
medications:_____

Diabetes	( )yes	( )no	Otitis	( )yes	( )no	TCE	( )yes	( )no
Measles	( )yes	( )no	High fever	( )yes	( )no	Mumps	( )yes	( )no
AVE	( )yes	( )no	Rubella	( )yes	( )no	Syphilis	( )yes	( )no
Meningitis	( )yes	( )no	Toxoplasmosis	( )yes	( )no	Cytomegalovirus	( )yes	( )no
Surgery	( )yes	( )no	What: _____					

Others:_____
Familial record of D.A._____

Notes: _____

Information collected by: _____
Date: ___/____/___

Acoustic Cabin, both duly calibrated according to norm ANSI 3.6 (1969) (10,11).

4. Logoaudiometry: comprised the vocal evaluation and the patient was prompted to repeat a list of dissyllabic words at an intensity higher than the tonal average (500, 1000 and 2000 Hz) until his speech threshold was confirmed and represented by confirmation of 50% of the emitted stimuli. In addition to this, we researched the speech recognition percentage rate applied by means of a list of 25 monosyllabic words, proposed by Pen and Mangabeira - Albertinaz (1973), presented at a fixed intensity of 40 dBHL above the tonal average (500, 1000 and 2000 Hz). The normality is characterized by the obtainment of a hit rate higher than 88% of the stimuli presented. The test was also performed with the use of AC-40 Audiometer, of Interacoustic trademark with TDH-39 phones and Acoustic Cabin, both duly calibrated according to norm ANSI 3.6 (1969) (11,12).
5. Imitanciometry: comprised the static complacency of the middle ear so as to verify its volume graphically represented through the tympanometry. In addition, the Imitanciometry comprised the stapedial reflex research in the frequencies from 500 to 4000 Hz. We used a Middle Ear Analyzer of Interacoustic trademark, model AT 235, with 226 Hz probe, calibrated as per norm ANSI 3.6/ISO 389 (13).
6. AEP: the hearing electrophysiological evaluation comprised the Encephalic Trunk Audition Evoked Potential (AEP) intended to verify the integrity of the auditory nerve afferent system. The aspects analyzed included: the presence of waves I, III and V; replicability of each component latency; absolute latency rate of waves I, II and V; interpeak latency rate I-V, I-III and III-V; amplitude rate of wave V concerning wave I; interpeak latency interaural difference I-V and/or latency V. The equipment used was the Navigator Pro, of Bio-Logic trademark, collection electrodes of the auditory nerve electric activity and insertion phones ER-3A to expel the auditory nerve acoustically; as well as software AEP, calibrated under norm ANSI S1.40-1984 (14).

The individuals who had alteration in the parameters described as inclusion criteria did not take part in the study.

The data was analyzed by means of non-parametric tests due to the nature of the variables involved. For verification of equality or not between the ears, we used the "Wilcoscon's Test", with $p<0.05$. The possibility of the right and left ears equality rates were added, and the difference between the audiological procedure parameters carried out by the "Mann - Whitney's Test", $p<0.05$ was analyzed. When there was no equality between the ears, these would be treated as right ear and left ear until the end of the analysis and the said test would go on. For description of the sample population, we used the Descriptive Statistics: sex, age range, education, etc.

Results

The results are represented in Tables 1 and 2 and Graphics 1 and 2.

Discussion

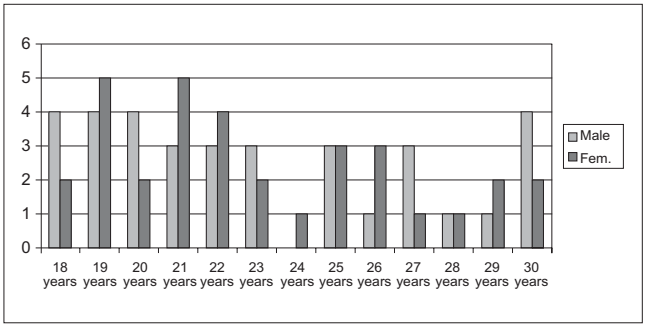
Since hearing is the sense that promotes the human communication, by developing the speech and the language of mankind, its integrity will prevent the promotion of an auditory deficit, which will cause qualitative (interpretation and codification) or quantitative (degree of lesion) alterations.

Aiming at analyzing the auditory nerve

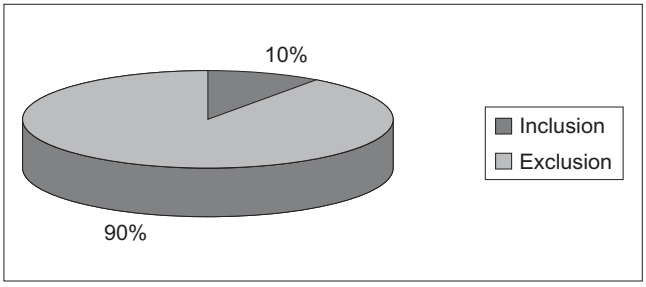
Table 1. Population studied as per sex and age range.

Age range	RE Present Sex		RE absent Sex		TOTAL
	Male	Fem.	Male	Fem.	N
18 years	4	2	0	0	6
19 years	3	5	1	0	9
20 years	4	2	0	0	6
21 years	3	5	0	0	8
22 years	2	4	1	0	7
23 years	2	2	1	0	5
24 years	0	1	0	0	1
25 years	3	2	0	1	6
26 years	1	2	0	2	5
27 years	3	1	0	0	4
28 years	1	1	0	0	2
29 years	1	1	0	1	3
30 years	4	2	0	0	6
Total	31	30	3	4	68

Legend: N = absolute value, number of evaluated individuals; RE = Stapedial Reflex.



Graphic 1. Division of the population studied as per sex and age range.



Graphic 2. Inclusion and Exclusion of individuals for the second stage of the research according to the basic demanded specifications.

Table 2. Characteristics of the AEP exam carried out in the second stage of the research, with values in milliseconds of waves I, III and V and values of interlatency between waves I-III, III-V and I-V.

	Latency						Interlatency					
	Wave I		Wave III		Wave V		I -III		III - V		I - V	
Patient	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE	RE	LE
I	1,87	1,82	3,66	3,57	5,57	5,36	1,79	1,75	1,92	1,79	3,71	3,54
II	-	1,86	-	3,66	-	5,53	-	1,79	-	1,82	-	3,71
III	1,82	-	3,57	-	5,36	-	1,75	-	1,79	-	3,54	-
IV	1,74	1,74	3,61	3,57	5,49	5,49	1,87	1,83	1,87	1,92	3,75	3,75

Legend: - exclusion of the values that do not present requirement to be met in the research.

electrophysiological evaluation findings through AEP in normal hearing patients, without auditory complaints, and who present absence of stapedial reflex, verified in the Imitanciometry, we evaluated 68 individuals in the data collection period. Out of the 68 individuals, 34 were male (50%) and 34 were female (50%), as described in Table 1 and Graphic 1.

By following the inclusion criteria for data collection, in the first month of collection, we evaluated seven individuals and four of whom presented the basic pre-requirements to pass to the next phase of the research (auditory thresholds within the normality standards, absence of auditory complaints, logoaudiometry compatible with the threshold tonal audiometry, type A tympanometric curve and absence of stapedial reflexes). However, the AEP equipment broke down in this period and it was impossible to go on with the research because it was an imported equipment of high cost and expensive maintenance. It was necessary to keep on with the research by means of the records of the "Hospital Universitário Dr. Domingos Leonardo Cerávolo" of patients who had already been through the exam.

61 records were analyzed (total number of people aged from 18 to 30 years old), that included the AEP exam. Out of the 61 records, only 1 had bilaterality and 2 had unilaterality - comprising the requirements demanded by the research.

Only 10% of the patients studied, as shown in Graphic 2, met the requirements for the second stage of the research (hearing within the normality standards, logoaudiometry compatible with the audiometry, type A tympanometric curve and absence of stapedial reflexes). Such data was similar to that by Rance et. al. (1999), who verified prevalence of the same characteristics in 11% of the population (15).

We carried out exams of thresholds tonal audiometry, logoaudiometry, imitanciometry (stapedial reflexes evaluation) and AEP, that became part of the battery of audiological tests used during the auditory neuropathy differential diagnosis (16,17).

The patients did not have auditory complaint, according to the elimination criterion, and the logoaudiometry results showed speech intelligibility levels within the normality standards and compatible with the audiometry (results compatible with the threshold tonal audiometry). In his studies, Berlin, 1999, shows that the speech recognition of the population with auditory neuropathy is compatible with the threshold tonal audiometry (16). But in another study, Kraus (2001) described that the auditory neuropathies affect the speech perception significantly, even in the individuals who have normal audiometric thresholds (18).

The AEP exams results showed integrity of the central auditory ways, as revealed in Table 2, differently from the study by Kraus (2001), who, for almost twenty years ago, found patients who had absence of responses in the Encephalic Trunk Audition Evoked Potential AEP and alteration of the stapedial exam, at the same time when the audiometric thresholds were within the normality standards or very close to them.

The auditory nerve disorder in the hearing neuropathy may be able to supply the basis of the acoustic reflexes loss. As per Starr (2001), in cases of auditory neuropathies, the auditory nerve may not process sufficiently a high rate of unload, required for the activation of the middle ear muscles acoustic reflex contractions (19).

Conclusion

The absence of stapedial reflexes by itself in patients without auditory complaints is not enough to diagnose the existence of auditory neuropathy, and the AEP exam should not be left out, even considering its high cost. The change to the neural synchrony does not justify the absence of the stapedial muscle reflex present in the auditory neuropathy and the loss of acoustic reflexes may second the axonal loss.

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