LATERALITY OF ACTIVITY OF MEDIAL OLIVOCOCHLEAR EFFERENT SYSTEM: PRELIMINARY STUDY

Lateralidade da atividade do sistema olivococlear medial eferente: estudo preliminar

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ABSTRACT

Purpose: to evaluate the difference in the suppression of otoacoustic emissions between the right and left ears **Methods:** participated in this study 36 individuals, being 18 right-handed and left-handed 18, all without hearing complaints and hearing within normal limits. Data collection was performed by: transient otoacoustic emissions and suppression of the otoacoustic emissions. The analysis of the presence / absence of the suppression effect was made based on the value obtained in response. **Results:** there was no difference between the right and left ears for the response values of otoacoustic emissions with contralateral noise for right and left handed individuals. In the male, there was a difference between the right and left ears for the response values of otoacoustic emissions with contralateral noise. **Conclusion:** the evaluation through the suppression of otoacoustic emissions showed no differences between the right and left ears in the groups studied.

KEYWORDS: Auditory Perception; Suppression; Efferent Pathways; Otoacoustic Emissions, Spontaneous; Functional Laterality

INTRODUCTION

Otoacoustic emissions are sounds produced in the cochlea and detected in the external acoustic meatus, it is specifically the registry of mobility and of mechanical skill of external hair cells[1]. The contralateral noise exerts inhibitory effect on the functioning of the external hair cells, the result is the reduction of the amplitude of otoacoustic emissions. This phenomenon, known as suppression effect of otoacoustic emissions, demonstrates the integrity of the medial system olivocochlear, since that innervate the external hair cells[2-4].

The mechanism by which the suppression effect of otoacoustic emissions occurs is not fully understood. It is believed that the medial olivocochlear efferent tract functions as a modulator. The medial olivocochlear efferent system adjusts active cochlear process through the slow contractions of the external hair cells, attenuates the rapid contractions and providing, specifically, a protective mechanism of the inner ear structures, by acoustic stimulation[3-5].

Researchers described differences in patterns suppression of evoked otoacoustic emissions between the right and left ear. Found interaural asymmetry, relative to the size of the amplitude of evoked otoacoustic emissions, It is greater right, and also as the action of the efferent auditory system, also more effectively to right[6-9]. The activity of the medial olivocochlear efferent tract, in both ears of 44 individuals between 19 and 29 years, with normal hearing, It was investigated to compare the inhibition of the bilateral tract. The evoked otoacoustic emissions by transient stimulus were researched with intensity of the click stimulus varying of 59-71 dB NPS, with contralateral acoustic stimulation of white noise to 30 dB the loudness level. It was observed higher activity of the efferent system on the

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right side, without significant difference according to gender[9].

In a study that compared the presence of the suppression effect of otoacoustic emissions and its amplitude in normal hearing adults individuals the authors observed no side dominance. There was no difference between the results of the right ear and left ear as to asymmetry of the amplitude size and as to presence of suppression effect[10].

Some authors verified the occurrence and the magnitude of the suppression effect of otoacoustic emissions by transient stimulus, in preterm infants, with risk factors for hearing loss and observed greater responses in the right ear[11]. Values greater of the amplitude suppression of transient otoacoustic emissions in the right ear using a noise in the ear contralateral and changes in amplitude of these emissions during tasks of auditory and visual attention indicate that the medial olivocochlear tract may be involved in maintaining this asymmetric peripheral standard and through him, the cortex can modulate cochlear function[8,9,12].

The laterality of the central nervous system or the predominance of one brain hemisphere above the other it is a topic much studied since dominant areas for language in the left hemisphere have been described. However, only with the advent of functional imaging exams it was possible better understand this asymmetric functioning and analyze whether the absence of this predominance can collaborate with the appearance of conditions such as dyslexia, aphasia, schizophrenia and autism[13-15]. On the other hand, determine this asymmetry is not easy task. Beyond the various levels of hemispheric dominance, the asymmetry may be different in the same individual, for the various members and sensory organs. Thus, there can be crossed laterality for different organs and functions[12].

However, there is evidence that the central and peripheral auditory system also function in lateral way. More amplitude of wave III in brainstem audiometry and of the transient otoacoustic emissions in the right ear n counterpart with most presence of tinnitus and of temporary hearing loss after exposure to noise in the left ear suggest, in addition to an asymmetry between the ears, that the left ear is more vulnerable to hearing alterations[8].

Therefore, this research was justified by the possibility of understanding the performance of the medial olivocochlear efferent system as it relates to the hearing dominance. Thus, the objective of the study was to evaluate the difference in the suppression of otoacoustic emissions between right and left ears.

METHODS

The procedures in this study were approved by the Research Ethics Committee of Pontifícia Universidade Católica de Minas Gerais (PUC Minas), under protocol number 0342.0.213.000-10 (Resolution 196/96 National Health Council – CONEP).

This research characterized by a pilot study, of descriptive typology, of qualitative and quantitative analysis. Were invited to participate of the study 60 subjects. These, ten refused to participate of the research, six not attend for the evaluation and the other 8 were excluded of the study by present hearing loss, hearing complaints and/or previous ear disease. The sample, so, was composed by 36 subjects (18 right-handed and left-handed 18), of both genders, in the age range of 18-25 years.

The research participants were selected in the undergraduate courses offered by the Instituto de Educação Continuada – IEC da Pontifícia Universidade Católica de Minas (PUC Minas) and in the social environment of the Researchers. The subjects of this study were selected by means of the non-random sampling technique, of the type convenience sampling.

The participants of the research were communicated personally about the objectives of the research, the absence of damage to your health, the guarantee of confidentiality of their identities or any other characteristics which could identify them, and on the roadmap of the research. Being properly informed, all signed the Consent Term.

The data collection was carried in the Clinical Center for Speech – Language Pathology and Audiology of PUC Minas. All the individuals were submitted to basic audiologic evaluation. This evaluation consisted of: anamnesis, otoscopy, pure tone audiometry, logoaudiometry, tympanometry and research of acoustic reflexes.

In the anamnesis the individual provided information as personal data, audiological history, health-related aspects and domain of manual motor ability (right or left handed). The anamnesis was conducted with the same protocol used in the Clinical Center for Speech – Language Pathology and Audiology of PUC Minas.

To perform the visual inspection of the external auditory canal (otoscopy) was used otoscope, of the brand TK®, model 22. The Pure tone audiometry and logoaudiometry were performed in acoustically treated booth and with two-channel audiometer, model Midimate 622, of the brand Madsen Electronics®, using phone TDH-39 and bone vibrator B-71. The tympanometry and the research of acoustic reflexes were performed through the

middle ear analyzer, model AZ7, of the brand Interacoustics®.

Were used as inclusion criteria to constitute the study group, individuals without hearing complaints and/or previous ear disease and with audiometry assessment within the normal range. It was considered individuals with hearing evaluation within normal standards those with pure tone thresholds by air conduction to 25 dBNA, in the frequencies of 250 Hz to 8 kHz, and pure tone thresholds by bone conduction to 15 dBNA, in the frequencies of de 500 Hz to 4 kHz, with difference between the thresholds of air conduction and bone conduction less or equal to 10 dB, tympanometric curve type A and presence of acoustic reflexes in the frequencies of 500 Hz, 1, 2 and 4 kHz.

Were excluded from the study neurological disorders individuals, cancer, ear infections, tympanic membrane perforation, he with a history of head trauma and otologic surgery, the with tinnitus, with exposure history of noise, in use of ototoxic drugs, with hearing complaints and hearing loss.

Then, the individuals were submitted to research of transient evoked otoacoustic emissions and the suppression of transient otoacoustic emissions. Each participant submitted himself only an assessment of transient otoacoustic emissions and suppression of transient otoacoustic emissions. First, was held a record of transient otoacoustic emissions in one ear and, then, a record in the other ear. Posteriorly, was held a suppression recording of transient otoacoustic emissions in one ear and, then, a record in the other ear. Therefore, the collection was held alternately between the ears.

The transient otoacoustic emissions were performed in comfortable and quiet environment with linear stimulus, type click, with intensities from 80 e 85 dB NPS. The number of stimuli used during registration of transient otoacoustic emissions did not suffer variation (260 series), wherein the procedure presented in the maximum duration of 75 seconds in each ear. Was considered noise level below 16dB NPS. The transient otoacoustic emissions were taken initially without contralateral noise, and then, with contralateral noise with the order not to change the placing the probe during the two test cases.

The transient otoacoustic emissions were performed by otoacoustic emission equipment model ILO version 6, of the brand Otodynamics®. To investigate the effect of suppression of transient otoacoustic emissions was used broadband noise transmitted by the two-channel audiometer, model Midimate 622, of the brand Madsen Electronics®, by means of the phone TDH-39, in the intensity of 60 dB NPS.

The transient evoked otoacoustic emissions were found to be present when the amplitude of the frequencies of 1 e 1,4, 2, 2,8 e 4 kHz were greater or equal to 3 dB in at least three consecutive frequencies reproducibility having values greater than 50% and values of stability of the adjustment of the probe greater than 70%. Only individuals who had transient evoked otoacoustic emissions present were included in the study.

For the effect of suppression observed the variation of the response of amplitude in the presence of noise, in relative the response of amplitude in the absence of noise. The value of the suppression referring to the action of the olivocochlear system is given by the difference of the values obtained in the conditions with and without contralateral stimulation, in each ear, and that value determines whether or not suppression. The value of this difference represents quantitatively the magnitude of the reduction / suppression. So, if the value is positive, there suppression and if it is negative or zero, there is no suppression in the emission amplitudes[10]. In this study we chose to by considering a minimum variation of 0.5 dB NPS and the analysis of the presence / absence of effect reduction / suppression was made based on the value obtained in response, excluding the interference of background noise.

Then the data collected were tabulated and subjected to statistical analysis. The statistical analysis was performed by of the software Statistical Package for Social Sciences (SPSS) version 20.0. Initially was performed the descriptive analysis, that understood measures of central tendency (mean and median), of dispersion (standard deviation) and of position (maximum and minimum).

Besides descriptive statistics was performed the inferential statistics by of the test t of Student paired. It was adopted the level of significance of 5% ($p \leq 0.05$). It was considered as trend to statistical significance the results significant at level of 10% ($p \leq 0.10$).

RESULTS

The mean age of the study population was 22,0 years (standard deviation 2,46). Being that 18 subjects were female, mean age of 22,8 years (standard deviation 1,84) and 18 subjects were male, mean age of 21,2 years (standard deviation 2,75). In the group of right-handed individuals, the mean age was of 22,3 years (standard deviation 2,08) and in the group of left-handed individuals, the mean age was of 21,7 years (standard deviation 2,81).

The descriptive analysis, considering the whole sample, can be visualized in the Table 1. It can be observed that, the mean of response values of otoacoustic emissions with and without contralateral noise were higher for the right ear.

Table 1 – Measures of central tendency, dispersion and position for the results otoacoustic emissions and otoacoustic emissions suppression (n=36)

Parameters		Mean	Median	DP	Maximum	Minimum
Response SR						
	OD	18,97	18,65	5,74	27,1	8,2
	OE	17,77	18,25	4,30	25,7	10,8
Response CR						
	OD	17,36	16,75	6,00	26	5,6
	OE	15,95	16,85	4,90	24,7	7,5
Magnitude reduction						
	OD	1,60	1,55	0,97	5,5	0,5
	OE	1,82	1,2	1,73	8,4	0,5

Legend: DP = standard deviation; SR = without contralateral noise; CR = with contralateral noise; OD = right ear; OE = left ear

The Table 2 shows the comparison between right-handed and left-handed individuals for the measures of central tendency. In the Table 3 shows the comparison between the female and male genders for the measures of central tendency.

In the inferential statistical analysis, considering the whole sample, was found that there was no difference between the response values of otoacoustic emissions without contralateral noise between the right and left ears (p=0,155) and that also there was no difference between the response values of otoacoustic emissions with contralateral noise between the right and left ears (p=0,104). In relation to magnitude of the reduction, it was observed that there was no difference between the right and left ears (p=0,420).

In the group of right-handed individuals was found that there was no difference between the response values of otoacoustic emissions without contralateral noise between the right and left ears (p=0,523) and that also there was no difference between the response values of otoacoustic emissions with contralateral noise between the right and left ears (p=0,360). In relation to magnitude of the reduction, it was observed that there was no difference between the right and left ears (p=0,380).

In the group of left-handed individuals, was found that there was no difference between the response values of otoacoustic emissions without contralateral noise between the right and left ears (p=0,151) and that also there was no difference between the response values of otoacoustic emissions with contralateral noise between the right and left ears (p=0,166). In relation to magnitude of the reduction, it was observed that there was no difference between the right and left ears (p=0,891).

In female gender, was found that there was no difference between the response values of otoacoustic emissions without contralateral noise between the right and left ears (p=0,808) and that also there was no difference between the response values of otoacoustic emissions with contralateral noise between the right and left ears(p=0,637). In relation to magnitude of the reduction, it was observed that there was no difference between the right and left ears (p=0,457).

The Table 4 allows observing that, in the male gender, there was trend to difference between the right ear and left ear for the response values of otoacoustic emissions without contralateral noise and that there was difference between the right and left ears for the response values of otoacoustic emissions with contralateral noise.

Table 2 – Measures of central tendency, dispersion and position for the results otoacoustic emissions and otoacoustic emissions suppression for right-handed and left-handed individuals

Parameters		Mean	Median	DP	Maximum	Minimum
Right-handed						
Response SR						
	OD	18,1	18,4	5,88	27,1	8,2
	OE	17,23	18,25	4,46	25,7	10,8
Response CR						
	OD	16,45	17	6,23	25,8	5,6
	OE	15,2	16,85	5,29	24,7	7,5
Magnitude reduction						
	OD	1,64	1,3	1,21	5,5	0,5
	OE	2,03	1,1	2,10	8,4	0,8
Left-handed						
Response SR						
	OD	19,85	19	5,63	27	9,1
	OE	18,31	19,2	4,19	24,6	11,4
Response CR						
	OD	18,27	16,45	5,80	26	7,3
	OE	16,7	17,75	4,49	22,5	9,2
Magnitude reduction						
	OD	1,57	1,65	0,69	3,1	0,5
	OE	1,61	1,4	1,29	6,4	0,5

Legend: DP = standard deviation; SR = without contralateral noise; CR = with contralateral noise; OD = right ear; OE = left ear

Table 3 – Measures of central tendency, dispersion and position for the results otoacoustic emissions and otoacoustic emissions suppression for male and female gender

Parameters		Mean	Median	DP	Maximum	Minimum
Female gender						
Response SR						
	OD	18,61	18,65	5,34	26,5	9
	OE	18,3	18,05	4,48	25,7	12,1
Response CR						
	OD	16,78	16,75	5,74	25,5	5,6
	OE	16,12	16,85	5,36	24,7	8,7
Magnitude reduction						
	OD	1,83	1,8	1,19	5,5	0,5
	OE	2,17	1,4	2,16	8,4	0,9
Male gender						
Response SR						
	OD	19,33	19,05	6,25	27,1	8,2
	OE	17,25	18,25	4,18	22,6	10,8
Response CR						
	OD	17,95	16,7	6,36	26	6,6
	OE	15,77	16,85	4,54	21,3	7,5
Magnitude reduction						
	OD	1,38	1,4	0,65	2,8	0,5
	OE	1,48	1,15	1,11	5,5	0,5

Legend: DP = standard deviation; SR = without contralateral noise; CR = with contralateral noise; OD = right ear; OE = left ear

Table 4 – Comparison between right and left ears for the results otoacoustic emissions and otoacoustic emissions suppression for male gender

Parameters	OD			OE			Valor-p
	Mean	Median	DP	Mean	Median	DP	
Response SR	19,33	19,05	6,25	17,25	18,25	4,18	**0,059**#
Response CR	17,95	16,7	6,36	15,77	16,85	4,54	**0,048***
Magnitude reduction	1,38	1,4	0,65	1,48	1,15	1,11	0,754

Legend: DP = standard deviation; SR = without contralateral noise; CR = with contralateral noise; OD = right ear; OE = left ear

* Significant values (p≤0,05) - Test t paired

Values with trend towards statistical significance (p≤0,10)

DISCUSSION

In similar studies no differences were found for the presence of suppression effect of evoked otoacoustic emissions as regards right and left dominance in adults with hearing within normal limits[6,10].

However, in another study, the researchers have documented differences in patterns of suppression of evoked otoacoustic emissions as the right and left ears. The researchers showed interaural asymmetry, in relation to evoked otoacoustic emissions, being greater right, and, as the action of the efferent auditory system, also with more effectively right. However, these researchers did not explain the motives of their findings, highlighting the need for further investigations to explain the asymmetry found[9].

In the present study the mean of the response values of otoacoustic emissions without contralateral noise and with contralateral noise was higher to right. However, this result was not observed for the magnitude of the reduction of otoacoustic emissions. The mean of the magnitude values of reduction of otoacoustic emissions it was higher to left.

In research conducted with right-handed with hearing within normal limits, the suppression was significantly greater in the right ear. As most of the study participants was right-handed, the probable explanation for this finding is the lateralization of the medial olivocochlear system[7,4,12].

In the present study, the participants were divided into 2 groups, a group of right-handed individuals and a group of left-handed individuals. However, the mean of the magnitude values of reduction of otoacoustic emissions it was higher to left both for right-handed individuals as for left-handed individuals.

In other studies statistically significant differences between the side of the ear in nursing infants were observed wherein the right side had higher responses[2]. The authors suggested that there is an asymmetric activity between the ears and, consequently, a magnitude of greater suppression on the right ear[3,11]. Such findings provide new arguments in favor of the peripheral auditory lateralization, especially in regard to the medial efferent system. Some authors argue that there is a predominance of the right ear on the left ear the that indicates a probable influence of olivocochlear tract. Thus, believe that a better function of the efferent medial system on the right would lead to greater protection of the external hair cells that, consequently, would generate greater suppression effect. Besides, would trigger efferent reflexes more effective on this side of, reflecting a balance between the function of the external hair cells and of the medial efferent system[12].

It is emphasized that the studies about suppression of otoacoustic emissions that the objective of investigating differences between the laterality patterns are scarce. Existing studies show great methodological variability, the that undertakes the comparison. Besides, the same level of stimulus presented in otoacoustic emissions can produce different answers in different individuals, and this inter-subject variability will be reflected, consequently, in level of suppression[2].

Therefore, it is necessary that other studies be developed to propitiate new comparisons and discoveries. The existing studies have defined various parameters for get the best catchment records of the otoacoustic emissions and of the suppression effect otoacoustic emissions, for example, the analysis interval of the amplitude response, the intensity of contralateral noise versus suppression amplitude, the bilateral mode of catchment in comparison to the ipsilateral or contralateral and time intervals[1,8]. However, there is still a gap how much the gender factor and the lateralization factor for right and left ears.

In the present study, the participants were also divided according to gender, but no differences were found between right and left ears for the suppression of otoacoustic emissions in the female

gender. This fact, probably, could be justified, also, by the absence of difference between right and left ears for the response values of the transient otoacoustic emissions without contralateral noise. However, the male gender differences were found between right and left ears for the suppression of otoacoustic emissions and for the response values of the transient otoacoustic emissions without contralateral noise.

The physiology and anatomy of the efferent pathway, particularly of the tract medial olivocochlear efferent, are still unknown. It is emphasized, then, the need for more detailed knowledge of the implications of the occurrence of a lateral dominance for the otoacoustic emissions mechanism suppression.

It is emphasized yet that a rigorous sample selection is necessary in studies of laterality and functional predominance. It is possible to have cross-laterality for different organs and functions, therefore the selection of right-handed individuals does not prove that these too have predominant right auditory systems. For this proof, electrophysiological tests with stimulus verbal, tonal and dichotic listening they should be realized at the includion time of participants for determining of the real hearing predominance[9-12].

CONCLUSION

The results of this study were not conclusive. The assessment carried out by means of otoacoustic emissions suppression showed no differences between the right and left ears for all groups studied. Although without statistically significant difference, was observed right ear advantage for the response values otoacoustic emissions with and without contralateral noise for all groups studied. The difference between the ears in the male gender should be considered with caution, once there is data not consistent the literature studied. Therefore, to affirm that there is acting of the medial olivocochlear efferent system as it relates to the hearing dominance, other studies must be performed with larger casuistry and having criteria of inclusion different, as, for example, the determining auditory predominance.

RESUMO

Objetivo: avaliar a diferença na supressão das emissões otoacústicas entre as orelhas direita e esquerda. **Métodos:** participaram da pesquisa 36 indivíduos, sendo 18 destros e 18 canhotos, todos sem queixa auditiva e com audição dentro dos padrões de normalidade. A coleta de dados foi realizada por meio das emissões otoacústicas transientes e pela supressão das emissões otoacústicas. A análise da presença/ausência do efeito de supressão foi realizada baseada no valor obtido em response. **Resultados:** não houve diferença entre a orelha direita e esquerda para os valores de response das emissões otoacústicas com ruído contralateral para os indivíduos destros e canhotos. No gênero masculino houve diferença entre a orelha direita e esquerda para os valores de response das emissões otoacústicas com ruído contralateral. **Conclusão:** a avaliação realizada por meio da supressão das emissões otoacústicas não evidenciou diferenças entre as orelhas direita e esquerda nos grupos estudados.

DESCRITORES: Percepção Auditiva; Supressão; Vias Eferentes; Emissões Otoacústicas Espontâneas; Lateralidade Funcional

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