Atividade Coclear Assimétrica: Influência do SNC?

Asymmetrical Cochlear Activity: A CNS Influence?

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RESUMO

Introdução: A predominância de um hemisfério cerebral sobre o outro já está bem estabelecida e há indícios que esta predominância pode ocorrer também ao nível do sistema auditivo periférico por influência do trato olivococlear medial.

Objetivo: Estudar esta predominância coclear comparando as EOAPD e a supressão das EOAPD nas orelhas esquerda e direita de indivíduos destros.

Casuística e Método: Neste estudo de corte transversal, 44 voluntários destros com audiometria normal e sem zumbido foram submetidos a EOAPD na ausência e na presença de um ruído branco na orelha contralateral. Comparamos a amplitude das EOAPD e a proporção de supressão destas EOA nas orelhas esquerda e direita dos participantes.

Resultados: A orelha direita apresentou amplitudes de EOAPD significativamente maiores nas freqüências de 1000, 1500, 2000 e 3000 que a orelha esquerda e maior proporção de supressão destas EOAPD nas freqüências de 1000, 2000, 3000 e 4000 Hz.

Conclusão: A atividade coclear à direita foi estatisticamente maior na orelha direita do que na esquerda, porém esta predominância não é regular em toda extensão coclear.

Unitermos: Predominância hemisférica, emissão otoacústica, destros, sistema auditivo eferente.

ABSTRACT

Introduction: The cerebral hemispheric advantage is already well-established and there are many indications of advantage as of the peripheral auditory system by medial olivocochlear tract influence.

Objective: To study this cochlear advantage comparing the OAEDP and the suppression of OAEDP in the left and right ears of right-handed subject.

Material and Methods: 44 right-handed subjects with normal hearing and no tinnitus underwent OAEDP without and with contralateral white noise. We

	compare the OAEDP amplitude and the OAEDP suppression proportion in the left and in the right ears.
Results:	The right ear presented significantly greater OAEDP amplitude at 1000, 1500, 2000 and 3000 than the left ear and a greater OAEDP suppression proportion at 1000, 2000, 3000 and 4000 HZ.
Conclusion:	The cochlear activity was greater in the right ear than in the left ear; however this advantage is not regular along the cochlea.
Key words:	Hemispheric advantage, otoacoustic emission, right-handed, efferent auditory system.

INTRODUCTION

The laterality of the Central Nervous System or the predominance of one brain hemisphere above the other is studied since Paul Broca (1861) and Carl Wernicke (1874) described the left side as a dominant area for language, but that asymmetric work (1) and studying whether the absence of this predominance can contribute with the appearing of dyslexia, schizophrenia and autuism (2,3), was only possible to be understood with functional imaging exams.

On the other hand, to clinically establish this asymmetry is not a simple task. Hemisphere predominance has different levels of intensity, and it can even differ in an individual in several sensory members and organs, in such a way that different organs and functions can be traversed. It is more regular to describe laterality issue examining the dominance of the superior, inferior limbs and of the eye system.

Therefore, there are also evidences that the central and peripheral hearing system works in a lateral way. More amplitude of wave III on brainstem audiometry and on transient evoked otoacoustic emissions (TOAE) on the right ear (RE) counterpart tinnitus presence and temporary hearing loss after noise exposure on left ear (LE) imply asymmetry between the two ears, and also that LE is more vulnerable to hearing alterations (4-6).

Greater values of the amplitude suppression of TOAE on RE having noise on the opposite ear (4,7) and changing on amplitude of these emissions during hearing and visual attention tasks (8) indicate the medium olivocochlear tract can be involved with the maintenance of and through this asymmetric peripheral standard, cortex can modulate cochlear function.

Then, the target of this work is to study asymmetry of cochlear function comparing amplitude of otoacoustic emission by distortion product (OAEDP) and suppression amplitude of OAEDP on RE and LE on right-hand dominant individuals.

RECORD AND METHOD

This project had the approval of the Ethics Committee of *HCFMUSP* (*CAPPesp*, protocol number 544/00).

A study was done with 44 individuals without hearing complaints aging 46.8 years as an average (standard deviation = 9.5 years). 14 (31.8%) of individuals were male.

The criteria for inclusion were the following:

- Right-hand individuals according to the summarized version of Edinburgh questionnaire (9);
- Absence of tinnitus;
- Bilateral normal tonal audiometry (threshold up to 25 dBNA in frequencies from 250 to 8000Hz) and asymmetric in all frequencies ($p \geq 0,26$);
- Normal impedance test;
- Otoacoustic presence by distortion product in frequencies from 1 to 6kHz);
- Awareness of the research, with signature of the post-information approval term.

In order to measure OAEDP (2f1-F2), it was used a Celesta 503 – version 3.xx (Madsen Electronics, Taastrup, Denmark). The responses were analyzed on the frequency graph by amplitude. The acoustic suppressor stimulus used was a white noise coming from an audiometer Maico, MA 32, via headphone TDH39 and MX41 pad**,** in intensity of 50 dBNA. With the purpose of avoiding manipulation of the probe of OAEDP, the headphone was attached to contralateral ear at OAEDP capture before starting the test. Despite all that, OAE probe was systematically tested before the capture of each sequence.

Instead of total amplitude of OAEDP, it was considered signal-to-noise ratio of 6dB in each frequence. The capture of OAEDP occurred first at the absence of white noise in the contralateral ear and aftwards at its presence.

The calculation of the suppressor effect of OAEDP was done by subtracting from signal-to-noise ratio obtained without contralateral noise, the value of signal-to-noise ratio with the usage of contralateral noise, for each specific frequency. Positive results (numbers) indicated suppression of OAEDP and negative ones or zero indicated no suppression.

In order to determine the laterality of cochlear working, we can compare the results obtained from left and right ears of the participants.

Associations were tested with McNemar qui-square test (for suppression values) and with t-paired (for otoacoustic emission values) according to the methods previously described (10). We consider $p \leq 0.05$ as level of statistical significance.

RESULTS

1. *Comparison of OAEDP values between left and right ears.*

Results of OAEDP obtained at left and right ears of the participants are displayed on Table 1. OAEDP were meaningfully greater at right ear in frequencies of 1000, 1500, 2000 and 3000 Hz. There was no association between laterality and amplitude of OAEDP in frequencies of 4000 and 6000 Hz, i.e, the differences between the two ears did not reach the level of statistical significance. Therefore, when in 4000 Hz the amplitude of OAEDP was greater at right (p=0.06) and when in 6000 Hz the amplitudes of OAEDP were very similar among themselves, with a slight predominance at left (p=0.59).

2. *Comparison of OAEDP suppression values between left and right ears*

Results of OAEDP suppression obtained at left and right ears of the participants are displayed on Table 2. Suppression was meaningfully greater at right ear in frequencies of 1000, 2000, 3000 and 4000 Hz. There was no association between laterality and suppression of OAEDP in frequencies of 1500 and 6000 Hz, i.e, when in 1500 Hz the suppression was slightly greater at right (p=0.56) and when in 6000 Hz slightly greater at left.

DISCUSSION

A detailed study of OAEs and the action of medial olivocochlear tract above them show important data on cochlear activity. Medial olivocochlear tract performs over external ciliated cells (ECCs) causing hyperpolarization by the discharge of acetylcholine on the synaptic gap (11,12). This hyperpolarization occurrs when opposed to depolarization, naturally induced by sonorous stimuli and it is distinguished by amplitude reduction of otoacoustic emissions (OAEs) with the usage of acoustic stimulation on contralateral ear (13,14). This efferent reflex has the function, among others, of preventing ECCs from harmful stimulation of intense noise.

The results suggest a predominance of RE over LE, as much as OAEDP amplitude is analyzed, as a percentage of OAEDP suppression, according to other studies, which use TOAE (4,7,15), and also suggest that there is a maintenance of hemispheric predominance at peripheral level by a likely inflency from the medial olivocochlear tract (16).

In this way, we say that a better function of the medial olivocochlear tract at right leads to a better protection of the ECCs, what produces greater OAEs and arises more effective efferent reflexes on this side, reflecting a balance between ECC function and medial olivocochlear tract, with functional predominance at right. Perhaps this might explain a greater presence of tinnitus and temporary hearing loss after exposure to noise on LE.

Therefore, as suggested in the literature, it seems that this right cochlear predominance on right-hand-dominant individuals does not occur in a symmetric and regular way, in all frequencies, where there is a changing of function of the medial olivocochlear tract between ears (4,7). On Table 2 we can observe that in 1500 Hz and in 6000 Hz both ears present very similar percentages of supression, without predominance signs; while Khalfa et al refer to a greater suppression of TOAE at left in 2400 Hz on right-hand-dominant individuals (4).

When we analyze the amplitude of OAEDP, we can see that in 4000 Hz the amplitude was greater at right, in spite of the level of statistical significance was not reached, as it occurred in frequencies between 1000 and 3000 Hz. Yet in 6000 Hz, OAEDP amplitudes were very similar between both ears, with a slight predominance of left ear, exactly as on results of OAEDP suppression.

A narrow selection of the participants is necessary for the laterality and functional predominance study. As metioned before, it is possible to happen traversed lateralities for different organs and functions, though a selection of right-hand-dominant individuals does not attest that they have predominant hearing system at right (or predominant left hearing cortex). For this attestment, electrophysiological tests with verbal, tonal stimulus and dichotic hearing (4,7,17) should be done at the includion time of the participants in order to determine the real hearing predominance.

In these terms, there is a chance of having included, on the sample, right-hand-dominant individuals with functional predominance of the hearing system at left as well as at right, what makes us think that, perhaps, this association between right-hand-dominant individuals and cochlear functional predominance at right is greater than what we have said.

There is no ideal and well stablished protocol of the medial olivocochlear tract function in the litearture, it may be because of the many variables to be controlled, what can influence on the interpretation of the obtained results. We have chosen for instance to use white noise as suppressor noise. Although white noise posseses energy in an ample frequency band, between 100 Hz and 10.000 Hz, there is a fall of efectiveness from 4000 Hz (18). It is important to mention that suppression occurs with specific frequency and it is proportional to intensity of supressor noise.

Therefore, results in 6000 Hz, where we did not find functional predominance of one ear above the other, on both OAEDP amplitude and on percentage of supression, can either reflect these physiological mechanisms or be originated from the used method, as the choice of white noise as suppressor noise, in the case of the suppression study of OAEDP amplitude.

Conclusion

Peripheral hearing system works in lateral way with functional predominance of RE over LE, on right-hand-dominant individuals. Probably, this occurs by the influency of medial olivocochlear tract, which does not seem to act in predominant and regular way in all cochlear extention.

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Table 1. Amplitude of OAEDP on left and right ear.

Frequency (F2)	Left Ear	Right Ear	p
1000 Hz			0.04
Medium	12.0	13.2	
Standard Derivation	4.3	4.7	
Min - max	6.1 – 23.4	6.5 – 23.2	
1500 Hz			0.01
Medium	12.8	14.6	
Standard Derivation	4.0	4.5	
Min - max	6.8 – 22.4	7.5 – 22.8	
2000 Hz			0.03
Medium	14.2	15.7	
Standard Derivation	4.4	4.7	
Min - max	6.3 – 25.1	7.9 – 25.2	
3000 Hz			0.01
Medium	14.0	16.0	
Standard Derivation	3.8	4.7	
Min - max	7.0 – 22.7	7.8 – 26.4	
4000 Hz			0.06
Medium	15.2	16.4	
Standard Derivation	4.1	4.8	
Min - max	6.5 – 27.3	9.1 – 30.8	
6000 Hz			0.59
Medium	15.5	15.1	
Standard Derivation	5.3	5.2	
Min - max	6.1 – 31.9	7.3 – 29.6	

Subtitle: *p* = value which corresponds to t-paired test.

Table 2. Supression of OAEDP on left and right ears.

Frequency (F2)	Left Ear	Right Ear	p
1000 Hz			0.005
Supression	23(52.3%)	36(81.8%)	
No Supression	21(47.7%)	8(18.2%)	
1500 Hz			0.56
Supressão	35(79.6%)	37(84.1%)	
No Supression	9(15.9%)	7(15.9%)	
2000 Hz			0.01
Supression	32(72.7%)	41(93.2%)	
No Supression	12(27.3%)	3 (6.8%)	
3000 Hz			<0.001
Supression	30(68.2%)	43(97.7%)	
No Supression	14(31.8%)	1 (2.3%)	
4000 Hz			< 0.001
Supression	24(54.5%)	40(91.0%)	
No Supression	20(45.5%)	4 (9.0%)	
6000 Hz			0.65
Supression	32(72.7%)	30(68.2%)	
No Supression	12(27.3%)	14(31.8%)	

Subtitle: *p* = value which corresponds to test of McNemar qui-square.