



CORRELATION BETWEEN CEREBRAL FUNCTIONAL LATERALITY AND EVOLUTION OF AUDIOMETRIC THRESHOLDS IN INDUSTRIAL WORKERS

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ABSTRACT **Objective:** To evaluate the relationship between cerebral laterality and the difference in evolution of the averages of audiometric thresholds in 3.0, 4.0 and 6.0 kHz.

Methods: A cross-sectional study with serial audiometry tests analyses evaluating the evolution of the arithmetic means in 3.0, 4.0 and 6.0 kHz of both ears in relation to the dominant hand of industrial workers

Results: The sample showed a predominantly male group with a mean exposure time of 152.8 months. Of the total, 92,9% workers were right-handed and 7,1% left-handed. The left side presented the worst mean in 48.2%, the right in 33.4% and 18.4% were indifferent. The Chi-square test showed no statistically significance between the worsening of the right side on left-handed or the left side on right-handed ($p=0,42$).

Conclusion: It was not possible to establish a relationship between the dominant hand and the involvement of one ear in relation to another.

KEYWORDS : Functional Laterality; Audiometry; Hearing Loss, Noise-Induced

INTRODUCTION:

Noise is defined as an unwanted and disturbing sound and in many workplaces, in one of the most common physical agents, being a primary hazard threatening occupational health. Prolonged exposure to loud sounds produces successive changes in the structure of the inner ear, transient at first and then permanent. The noise-induced hearing loss is commonly studied due to its irreversible character.^[1-3]

Approximately, 16% of adult cases of hearing loss are believed to be associated with workplace noise exposure and the concern about the worker's health has grown over the years and several studies have been carried out with the intention of preventing the annoyances that occupational exposure to noise can cause to the individual.^[5]

Noise-induced hearing loss (NIHL) is characterized by bilateral neurosensory loss due to systematic occupational exposure to high sound pressure levels. Its main characteristics are the irreversibility and the gradual progression with the time of exposure to risk. Initially, auditory threshold impairment occurs in one or more frequencies in the range of 3 to 6 kHz, and there is no progression in the decrease of thresholds once the exposure ceases.^[3-4]

Some symptoms may appear associated with NIHL, such as: tinnitus, difficulty of comprehension in speaking, odynacusis, auricular fullness feeling and recruitment, present in almost all cases.[2-4] Such symptoms, which are not always present symmetrically and bilaterally from the onset, and as demonstrated in several studies, may tend to predominate one ear over the other. This finding may be related to the predominance of the cerebral hemisphere.^[5]

OBJECTIVE:

To evaluate the relationship between cerebral laterality and the difference in the evolution of the averages of audiometric thresholds in 3.0, 4.0 and 6.0 kHz.

METHODS:

Study sample:

This study was a cross-sectional study involving a cerebral laterality evaluation and a hearing assessment, consisting of an otoscopic evaluation, admittance measures and pure-tone audiometry at two different dates in a period of one year. A noise-free period of at least 14 h before testing was required to rule out the presence of transient threshold shifts.

A cohort of 1,728 workers was recruited in three metallurgical industries at Mogi Mirim – São Paulo, Brazil and were evaluated two times in a period of one year (between 2014 and 2015).

All testing was performed in a quiet room. It was ensured that the ambient sound pressure levels did not exceed any of the levels specified by the International Organization for Standardization 8253-1 guidelines for accurate testing of normal air conduction hearing threshold levels.^[6]

To evaluate the cerebral laterality, the researchers asked the participant to kick a ball and to write their name with a pen, characterizing them in left-handed or right-handed.

The study was approved by the Ethical Committee of State University of Campinas – UNICAMP and was conducted in accordance with the ethical standards stipulated in the Helsinki declaration for research involving human subjects. All participants agreed with the informed consent, in which the aims of the study were described.

Audiometric evaluation:

Pure-tone audiometry was performed using the modified Hughson–Westlake method for air conduction thresholds at conventional octave frequencies from 0.25 to 8.0 kHz and half octave frequencies 3,0 and 6,0 kHz. For each participant, the PTA for high frequencies (further on denoted as PTA_{high}) was calculated as the average of air conduction thresholds at 3.0, 4.0, 6.0.^[7]

Statistical analysis:

The Chi-square test were used to verify the relationship between variables. To calculate precise estimation of proportion, 95% of confidence intervals were applied.^[8]

RESULTS:

Between 2014 and 2015, 1728 workers were evaluated. The time of exposure to noise ranged from 24 to 360 months (mean = 152.8 months). Of the total, 1680 (97.3%) were male and 48 (2.7%) female. The arithmetic mean of the auditory thresholds at 3.0, 4.0 and 6.0 kHz was calculated in both ears

The arithmetic mean on the right ear ranged from 1,7 to 55 (mean=12,8) (Table 1) and on the left ear from 1,7 to 53,3 (mean=13,4). (Table 2)

Table 1 – Variation of arithmetic mean of the auditory thresholds at 3.0, 4.0 and 6.0 kHz of the right ear

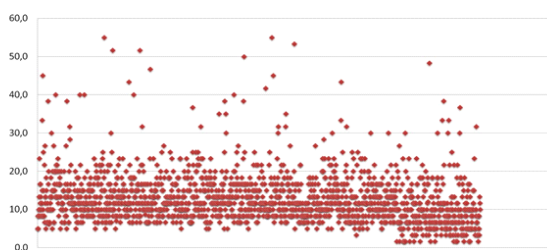
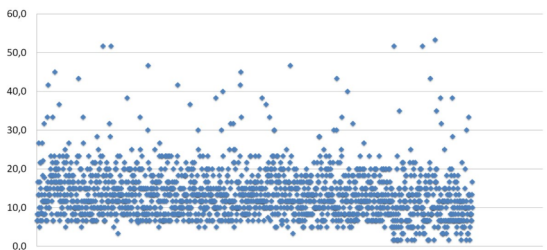
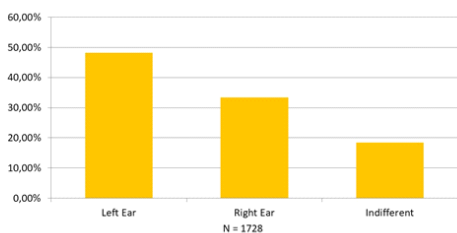


Table 2 – Variation of arithmetic mean of the auditory thresholds at 3.0, 4.0 and 6.0 kHz of the left ear



Of the total sample, 1607 (92,9%) workers were right-handed and 121 (7,1%) left-handed. In 832 (48,2%), the side that presented the worst mean was the left, in 577 (33,4%) the right and 319 (18,4%) were indifferent, meaning that both sides had the same mean evolution. (Table 3)

Table 3 - Predominant side of audiometric thresholds worsening in the total sample



Regarding only the right-handed workers the left ear had a predominant worsening on auditory thresholds in 48,2% of the group in comparison to the right ear in 33,3%. In 18,6% the worsening was indifferent.

On the left-handed group, the left ear also had a predominant worsening in 48,7% in contrast with the right ear (34,8%) and indifferent (16,5%).

The Chi-square test showed no statistically significance between the worsening of the right side on left-handed or the left side on right-handed in comparison to the other side (p=0,42). In fact, the percentages were similar in all workers.

DISCUSSION:

Noise is one of the main physical agents related to occupational health. Prolonged exposure to loud sounds produces successive changes in the structure of the inner ear.^[2-4]

Laterality of the Central Nervous System was first described by Paul Broca in 1861 and later by Carl Wernicke in 1874. [9] However, it was only possible to better understand the inter-hemispheric asymmetric functioning, with the appearance of functional imaging tests that were associated with several diseases such as schizophrenia, autism and dyslexia^[10,11] There is evidence that the peripheral and central auditory system also function laterally.^[11]

Khalifa *et al* described differences in suppression patterns of evoked otoacoustic emissions (EOAE) between right and left ears. The interaural asymmetry found regarding the amplitude of the EOAE and the action of the efferent auditory system are more effective on the right side. The medial olivocochlear tract acts on the movement of the outer hair cells (OHC), causing its hyperpolarization through the release of acetylcholine in the synaptic cleft and this efferent reflex has

the function of protecting the OHC against the aggressive stimulation of intense noises. This possible better functioning of the right medial olivocochlear tract would allow greater protection of the outer hair cells.^[11]

Some studies have shown increased amplitudes of wave III in Brainstem Evoked Response Audiometry and on transient EOAE in the right ear in comparison to the left.^[12] It was also shown a more pronounced temporary left hearing loss after exposure to noise, considering the left ear more vulnerable to auditory changes.^[13]

Fávero *et al.* demonstrated that right cochlear activity was greater than the left in the analysis of EOAE by distortion products in the frequencies of 1000 to 3000 that could suggest a better functioning of the right medial olivocochlear tract in the protection of OHC, explaining a possible left ear susceptibility for tinnitus and temporary hearing loss after exposure to noise.^[14]

Several studies have attempted to demonstrate that the left ear is more vulnerable than the right due to the proximity of the noise source and there is currently no study investigating whether the dominant hand could influence greater protection to the cerebral hemisphere and the ipsilateral ear.^[15-19]

CONCLUSION:

The sample showed a predominantly male group with a mean exposure time of 152.8 months. In right-handed and left-handed workers, there was no difference in the evolution of left and right ear averages, and it was not possible to establish a relationship between the dominant hand and the involvement of one ear in relation to another.

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