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ORIGINAL ARTICLE

Brainstem auditory evoked potentials in children with lead exposure☆

Katia de Freitas Alvarenga[a], Thais Catalani Morata[b], Andrea Cintra Lopes[a], Mariza Ribeiro Feniman[a], Lilian Cassia Bornia Jacob Corteletti[a,*]

[a] *Department of Speech Therapy and Audiology, Faculdade de Odontologia de Bauru, Universidade de São Paulo (FOB-USP), Bauru, SP, Brazil*
[b] *National Institute for Occupational Safety and Health (NIOSH), Division of Applied Research and Technology, Cincinnati, OH, United States*

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KEYWORDS
Toxicity;
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Abstract
Introduction: Earlier studies have demonstrated an auditory effect of lead exposure in children, but information on the effects of low chronic exposures needs to be further elucidated.
Objective: To investigate the effect of low chronic exposures of the auditory system in children with a history of low blood lead levels, using an auditory electrophysiological test.
Methods: Contemporary cross-sectional cohort. Study participants underwent tympanometry, pure tone and speech audiometry, transient evoked otoacoustic emissions, and brainstem auditory evoked potentials, with blood lead monitoring over a period of 35.5 months. The study included 130 children, with ages ranging from 18 months to 14 years, 5 months (mean age 6 years, 8 months ± 3 years, 2 months).
Results: The mean time-integrated cumulative blood lead index was 12 μg/dL (SD ± 5.7, range: 2.433). All participants had hearing thresholds equal to or below 20 dBHL and normal amplitudes of transient evoked otoacoustic emissions. No association was found between the absolute latencies of waves I, III, and V, the interpeak latencies I–III, III–V, and I–V, and the cumulative lead values.
Conclusion: No evidence of toxic effects from chronic low lead exposures was observed on the auditory function of children living in a lead contaminated area.

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* Corresponding author.
E-mail: lilianjacob@fob.usp.br (L.C.B.J. Corteletti).

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PALAVRAS-CHAVE
Toxicidade;
Intoxicação por chumbo;
Potenciais evocados auditivos do tronco encefálico;
Audiometria de tons puros

Potencial evocado auditivo de tronco encefálico em crianças com exposição ao chumbo

Resumo
Introdução: Estudos anteriores têm demonstrado efeitos da exposição ao chumbo no sistema auditivo em crianças, porém a exposição deste metal em níveis baixos ainda precisa ser investigada.
Objetivo: Investigar os efeitos da exposição crônica ao chumbo no sistema auditivo de crianças com histórico de baixo nível sanguíneo de chumbo por meio de um teste eletrofisiológico.
Método: Estudo de coorte transversal contemporânea. Foram realizados imitanciometria, audiometria tonal liminar e vocal, emissões otoacústicas evocadas transientes e potenciais evocados auditivos de tronco encefálico, com o monitoramento sanguíneo de chumbo durante um período de 35,5 meses. Participaram 130 crianças na faixa etária de 18 meses a 14 anos e 5 meses (6a8m $\pm$ 3a2m).
Resultados: A média estimada do índice de pumblemia foi 12 μg/dL (DP $\pm$ 5,7). Todos os participantes apresentaram limiares auditivos iguais ou inferiores a 20 dBNA e amplitude normal das emissões otoacústicas evocadas transientes. Não foi encontrada associação entre as latências absolutas das ondas I, III e V e interpicos I-III, III-V e I-V e os valores cumulativos de chumbo.
Conclusão: não foi observada evidência de efeitos tóxicos em baixas exposições crônicas ao chumbo sobre a função auditiva de crianças que vivem em uma área contaminada por este metal.

Introduction

Lead is a known neurotoxic agent that can cause serious damage to nervous tissue, particularly during development of the central nervous system, resulting in neurocognitive and neurophysiological disorders in children and adults. Both occupational and environmental sources of lead exposure constitute a public health concern.

Adverse health effects (especially in cognitive function, attention and learning) have been linked to low levels of lead in blood (<10–20 μg/dL).[1–5] In a review of the literature on the neurotoxicity associated with exposure of children to low levels of lead, the authors concluded that there is no safe level without neurological effects in the body (no adverse effect level), i.e., any exposure to lead is harmful to the central nervous system.[6] One of the goals of Healthy People Program 2020 of the U.S. Department of Health and Human Services (DHHS) included the elimination of lead levels in blood $\geq$10 μg/dL in children younger than 5 years of age by the year 2020.[7] In Brazil, there is no policy directed toward the prevention of poisoning by environmental exposure to heavy metals and current Brazilian standards still consider 40 μg/dL as the recommended biological index.[8]

Different types of evoked potentials and several neurobehavioral tests have been used to detect subclinical changes in individuals exposed to a range of lead levels, in order to prevent acute and/or persistent neurological disorders in exposed individuals.[9] Schwartz and Otto[10] suggested that the evoked potential may be the most sensitive indicator of central nervous system dysfunction in children. Evidence from studies on the effects of occupational exposure to lead on the human auditory system has been reported over the past three decades. Effects on latency and amplitude were reported in somatosensory, visual, and auditory evoked potentials, including cognitive evoked potential.[11–23] However, there is no consensus: (1) on the limit and the level of lead poisoning needed to induce effects on the auditory system of children; (2) which structures or functions of the auditory system are susceptible; and (3) the most sensitive tests for the assessment of lead poisoning effects.

The first study that used brainstem auditory evoked potential (BAEP) to investigate the effects on electrophysiological recordings in children exposed to lead was performed by Otto et al.[24] The results showed a significant association between the levels of blood lead (mean 28 μg/dL) and the absolute latencies of waves III and V, with an increase in latency correlating with the increased levels of lead in blood. This finding suggested the effect of this metal occurs at the level of the lower brainstem in the cochlear nucleus region. However, the presence of cochlear damage was not ruled out.

Subsequent studies in children with higher exposure levels (43–72 μg/dL) also described changes in BAEPs, which supported auditory system impairment, but with no consensus on which auditory system structures were affected. Some of these studies suggested peripheral lesions,[13,25] while others suggested both central and peripheral dysfunctions.[26] However, these findings were not confirmed in other studies,[27,28] which found no significant association between lead exposure and auditory function. An exception was the paper of Holdstein et al.,[13] that assessed the effects of lead levels in blood obtained from previous records. In this study, the researchers used lead