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ORIGINAL ARTICLE

The maturation state of the auditory nerve and brainstem in rats exposed to lead acetate and supplemented with ferrous sulfate ☆,☆☆

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KEYWORDS

Hearing;
Auditory evoked potentials;
Lead acetate;
Blood lead levels;
Ferrous sulfate

Abstract

Introduction: The literature has reported the association between lead and auditory effects, based on clinical and experimental studies. However, there is no consensus regarding the effects of lead in the auditory system, or its correlation with the concentration of the metal in the blood.

Objective: To investigate the maturation state of the auditory system, specifically the auditory nerve and brainstem, in rats exposed to lead acetate and supplemented with ferrous sulfate.

Methods: 30 weanling male rats (*Rattus norvegicus*, Wistar) were distributed into six groups of five animals each and exposed to one of two concentrations of lead acetate (100 or 400 mg/L) and supplemented with ferrous sulfate (20 mg/kg). The maturation state of the auditory nerve and brainstem was analyzed using Brainstem Auditory Evoked Potential before and after lead exposure. The concentration of lead in blood and brainstem was analyzed using Inductively Coupled Plasma-Mass Spectrometry.

Results: We verified that the concentration of Pb in blood and in brainstem presented a high correlation ($r = 0.951$; $p < 0.0001$). Both concentrations of lead acetate affected the maturation state of the auditory system, being the maturation slower in the regions corresponding to portion of the auditory nerve (wave I) and cochlear nuclei (wave II). The ferrous sulfate supplementation

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reduced significantly the concentration of lead in blood and brainstem for the group exposed to the lowest concentration of lead (100 mg/L), but not for the group exposed to the higher concentration (400 mg/L).

Conclusion: This study indicate that the lead acetate can have deleterious effects on the maturation of the auditory nerve and brainstem (cochlear nucleus region), as detected by the Brainstem Auditory Evoked Potentials, and the ferrous sulphate can partially amend this effect. © 2017 Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. Published by Elsevier Editora Ltda. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

PALAVRAS-CHAVE

Audição;
Potenciais evocados auditivos;
Acetato de chumbo;
Níveis de chumbo no sangue;
Sulfato ferroso

Estado de maturação do nervo auditivo e tronco encefálico em ratos expostos ao acetato de chumbo e suplementados com sulfato ferroso

Resumo

Introdução: A literatura relatou a associação entre o chumbo e os efeitos auditivos, com base em estudos clínicos e experimentais. No entanto, não há consenso em relação aos efeitos do chumbo no sistema auditivo, ou sua correlação com a concentração do metal no sangue.

Objetivo: Investigar o estado de maturação do sistema auditivo, especificamente do nervo auditivo e do tronco encefálico, em ratos expostos ao acetato de chumbo e suplementados com sulfato ferroso.

Método: 30 ratos machos desmamados (*Rattus norvegicus*, Wistar) foram distribuídos em seis grupos de cinco animais e expostos a uma de duas concentrações de acetato de chumbo (100 ou 400 mg/L) e suplementados com sulfato ferroso (20 mg/kg). O estado de maturação do nervo auditivo e do tronco encefálico foi analisado pelo Potencial Evocado Auditivo do Tronco Encefálico antes e após a exposição ao chumbo. A concentração de chumbo no sangue e tronco encefálico foi analisada utilizando-se Espectrometria de Massa por Plasma Indutivamente Acoplado.

Resultados: Verificamos que as concentrações de Pb no sangue e no tronco encefálico apresentaram alta correlação ($r=0.951$, $p<0.0001$). Ambas as concentrações de acetato de chumbo afetaram o estado de maturação do sistema auditivo, sendo a maturação mais lenta nas regiões que correspondiam à parte do nervo auditivo (onda I) e núcleos cocleares (onda II). A suplementação com sulfato ferroso reduziu significativamente a concentração de chumbo no sangue e tronco cerebral no grupo exposto à menor concentração de chumbo (100 mg/L), mas não para o grupo exposto à maior concentração (400 mg/L).

Conclusão: Esse estudo indica que o acetato de chumbo pode ter efeitos deletérios na maturação do nervo auditivo e do tronco encefálico (região do núcleo coclear), como detectado pelos potenciais evocados auditivos do tronco encefálico, e que o sulfato ferroso pode diminuir parcialmente esse efeito.

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Introduction

A significant association between higher lead (Pb) exposure and negative developmental outcomes including intelligence, cognitive, emotional and behavioral problems has been reported. Recently, low-level Pb exposure has been shown to have small, but significant negative impacts that persist across childhood and early adolescence, and into early adulthood.

The literature has also reported the association between Pb and auditory effects, based on clinical and experimental studies. However, there is no consensus regarding the effects of Pb in the auditory system, or its correlation with the concentration of the metal in the blood.¹⁻⁶

Given Pb's general toxicity in humans, some studies aimed to examine the protective effects of chelating agents, antioxidants, among others.⁷⁻⁹ A study⁸ presented a review about the beneficial effects of different antioxidants in preventing Pb body burden and oxidative stress. It finds that the administration of natural or synthetic antioxidants has been shown to be of benefit in the prevention and attenuation of metal induced biochemical alterations, but the human studies are still limited in this regard. In studies that have investigated the possible protective effects of iron (Fe) on Pb exposure, it was found that Fe prevented cytotoxicity and apoptosis induced by Pb,¹⁰ possibly protecting the integrity of the blood brain barrier.¹¹ In contrast, previous studies that examined the effect of Pb on the brain antioxi-

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