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Dental lead levels in children from two different urban and suburban areas of Turkey

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Abstract

The lead content of shed primary teeth has proved to be a reliable measure of cumulative lead exposure in children as it is an indicator of the degree of exposure over several years, from in utero life to loss of the tooth. Totally 297 shed deciduous teeth were collected from 263 children between ages 4 and 15 to determine the level of lead exposure in Ankara and Balıkesir in Turkey. Ankara is the capital of Turkey and characterized by heavy traffic and high air pollution. On the other hand, Balıkesir has less traffic. Balıkesir-Centre (R) had the highest mean (SD) lead level ($1.77 \pm 1.03\,\mu g/g$) whereas Ankara-Centre (U) had the lowest level ($1.30 \pm 0.59\,\mu g/g$). We could not observe a statistically significant difference between urban and suburban regions (Table 1), and in terms of type of tooth, incisors had a statistically significant higher lead level than canines and molars ($p < 0.05$, Table 2). No difference was observed between boys and girls and the accumulation of lead in teeth ($p < 0.05$, Table 3).

Keywords: Lead; Leaded gasoline; Deciduous teeth; Children; Atomic absorption Spectrometry assay

Introduction

The lead pollution of the environment is a global problem; the major part of lead pollution can derive from exhausted gases of vehicles. Lead is one of the most important and widely distributed pollutants in the environment (Frank et al., 1989). Human activities and the extensive use of lead in industry have resulted in redistribution of lead in the environment and, hence, the contamination of air, water, and food. As a consequence, the lead levels are significantly increased in the blood and body organs of human (Al-Mahroos and Al-Saleh, 1997). Lead in traffic exhaust is the main source of human lead absorption. It accumulates mainly in calcified tissues in the body (Steenhout, 1982), but the central nervous system is considered to be the critical organ of lead toxicity in children (WHO, 1987).

Small quantities of lead can cause profound biochemical and neurological changes in humans. Adverse effects arising from the exposure of children to lead represent a public-health problem, particularly in industrialized nations (http://www.cpsc.gov). The amount of lead in deciduous teeth has been used extensively as a marker for infant lead exposure and body burden (Robinowitz et al., 1991). Tooth biopsies in vivo or after the removal of teeth from the body provide an absolutely reliable source of information about the deposition therein of substances such as lead,

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fluoride and tetracycline. Furthermore, the age at which the deposition took place can also be determined with a high degree of accuracy (Grobler et al., 1996). Lead level in teeth is used as an index to environmental pollution. The more polluted the environment, the higher the lead level in teeth. Thus, differences in the lead level were found between urban or industrial areas and rural zones or between different areas of the same city (Karakaya et al., 1996; Gomes et al., 2004; Lyngbye et al., 1991). Experimental evidence shows a dose–response relationship between blood lead and dentin lead. Also, increasing lead levels have been documented in permanent teeth with increasing age (Lyngbye et al., 1991).

Measurements of lead (Pb) in bone reflect cumulative Pb exposure, whereas blood Pb levels are indices of absorption during the previous 21–30 days (current Pb exposure). (Rosen et al., 1993). Lead accumulates in bones and teeth but the amount of lead released from teeth is negligible, its annual aggregation in hard tissues can be considered to be directly related to blood levels. Thus, teeth are good indicators of environmental lead pollution and have been used by many researchers (Hernandez-Guerrer et al., 2004). Children are at increased risk because of their high risk of exposure and their increased capacity for absorption and retention (Rahman and Yousuf, 2002). Tooth lead levels have been used as an indicator of exposure to that metal, especially in growing children (Needleman et al., 1979).

In Turkey, many old vehicles still were on traffic for a long time despite toxicity of leaded gasoline. There had been no controls over exhaust emissions. However, Turkey steadily reduced lead in gasoline between 1988 and 2002. The lead content in high-octane leaded gasoline that contained 0.84 g/l in the pre-1988 period was reduced to 0.40 g/l in 1988 and 0.1 g/l in 2002 (Country Assessment Report, 1998).

Our goals were (1) to analyze the lead levels by atomic absorption spectrometry assay (AASA) in deciduous teeth of children who have been living in the same regions for last 5 years and to determine the extent of exposure, (2) to compare our results to a previous study carried out by Karakaya et al. (1996) in Turkey and to evaluate whether the environmental pollution from leaded gasoline had decreased or not with the use of unleaded gasoline.

Materials and methods

This study was carried out in Ankara. We collected 297 deciduous teeth from 263 children aged 4–15 years (157 boys, 140 girls) in two different cities, Ankara and Balıkesir. Teeth which were carious or contained dental fillings were not considered suitable for the study. To show the effects of leaded gasoline, 89 and 117 of these children were chosen from urban area (central of Ankara and Balıkesir), which is characterized by heavy traffic and high air pollution, and 22 and 69 of these children from suburban regions (Sincan and a village).

An interview was conducted for every chosen child and his/her parents for detailed history and any symptoms indicating lead exposure or toxicity. For each tooth, the dentist filled in a small slip with the date of birth, name and address of the child, duration of residence at the last dwelling place, the occupation of the father and mother, position of the tooth in the jaw, and in particular whether he or she lives near a main road or not.

Sample collection

Ten milliliter of polyethylene tubes and their covers were kept in 10% HNO_3 (nitric acid) for 48 h and rinsed with deionized water. They were dried at 50 °C during day. After tubes were labeled, the tubes and forms which were filled out by six dentists were sent to two policlinics in Ankara and Balıkesir. Each tooth was stored at −20 °C in a polyethylene tube which was cleaned in 10% HNO_3 for 48 h and rinsed in deionized water and dried for a day at 50 °C.

Reagents

Lead calibration solutions were prepared by dilution of the stock standard solution (1000 mg/ml Fisher Scientific, UK). $Mg(NO)_3 \cdot 6H_2O$ (was used as chemical modifier); H_2O_2 and HNO_3 were obtained from Merck (Darmstad, Germany).

Accuracy of the procedure was tested using standard reference material, NIST 1486, and bone meal.

Procedure

Tooth samples were analyzed for lead using a modified AASA described by Spevackova and Smid (1999).

The teeth were immersed to 10 ml of 5% H_2O_2 for 24 h, and then they were washed with deionized water and immersed into 10 ml of acetone for 24 h. After washing with deionized water the samples were dried at 50 °C in an oven for 24 h. Dried samples were weighed and classified into six groups according to their weights. They were placed into a Teflon beaker and dissolved in 2–7 ml concentrated HNO_3 on a hot plate. The digested samples were heated up to dryness and the residues dissolved in 3 ml of 0.7 M HNO_3 under heating and they were transferred to 10 ml flasks. The beakers were washed with 3 ml portions of 0.7 M HNO_3 twice and transferred to the volumetric flask. Then they were diluted to 10 ml.