

# Revista Internacional de Contaminación Ambiental

Revista Internacional de Contaminación  
Ambiental  
Universidad Nacional Autónoma de México  
rvp@atmosfera.unam.mx  
ISSN (Versión impresa): 0188-4999  
MÉXICO

2002

Armando Báez / Raúl Belmont / Sara Espinosa / Rocío García / Juan C. Hernández

LEAD ABSORPTION IN IMPACTED THIRD MOLARS

*Revista Internacional de Contaminación Ambiental*, año/vol. 18, número 002

Universidad Nacional Autónoma de México

Distrito Federal, México

pp. 75-79



## LEAD ABSORPTION IN IMPACTED THIRD MOLARS

Armando BÁEZ<sup>1\*</sup>, Raúl BELMONT<sup>1</sup>, Sara ESPINOSA<sup>2</sup>, Rocío GARCÍA<sup>1</sup> and Juan C. HERNÁNDEZ<sup>2</sup>

<sup>1</sup> Laboratorio de Química Atmosférica, Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, Coyoacán 04510 D. F., México

<sup>2</sup> División de Estudios de Posgrado e Investigación, Facultad de Odontología, Universidad Nacional Autónoma de México, Circuito Exterior, Ciudad Universitaria, Coyoacán 04510 D.F., México

*(Recibido marzo 2002, aceptado mayo 2002)*

Key words: teeth, impacted molars, third molars, teeth lead concentrations

### ABSTRACT

Lead levels in 56 whole impacted third molars of 15-28 years old people living in Mexico City were determined by graphite furnace atomic absorption spectrophotometry. Samples were classified by tooth position, age, and gender. Third molar concentrations showed a nearly log-normal distribution, therefore a non-parametric statistic was applied to estimate if there were significant differences among the mentioned variables and lead concentration. The geometric mean concentration ( $\bar{X}$  g) for all third molars was  $4.21 \pm 1.74 \mu\text{g g}^{-1}$ , having mandibular molars higher concentrations ( $\bar{X}$  g =  $4.53 \pm 1.62 \mu\text{g g}^{-1}$ ) than maxillary molars ( $\bar{X}$  g =  $3.87 \pm 1.86 \mu\text{g g}^{-1}$ ), however, no significant differences were found between them. The molars of the oldest donors presented the highest lead geometric mean concentration ( $\bar{X}$  g =  $5.81 \mu\text{g g}^{-1}$ ). Females' molars had higher levels than males' molars, with no significant differences between them.

Palabras clave: dientes, molares incluidos, terceros molares, concentración de plomo en dientes

### RESUMEN

Se determinaron por espectrofotometría de absorción atómica con horno de grafito los niveles de plomo en 56 terceros molares enteros impactados de gente entre 15 y 28 años de edad que radica en la ciudad de México. Las muestras se clasificaron por tipo de diente, género y edad. Las concentraciones de plomo de los terceros molares se ajustaron a una distribución aproximadamente log-normal, por lo tanto, se aplicó estadística no paramétrica para estimar si hay diferencias significativas entre las variables mencionadas y la concentración de plomo. La media geométrica ( $\bar{X}$  g) de todos los terceros molares fue de  $4.21 \pm 1.74 \mu\text{g g}^{-1}$ , con mayores concentraciones en los molares mandibulares ( $\bar{X}$  g =  $4.53 \pm 1.62 \mu\text{g g}^{-1}$ ) que en los molares maxilares ( $\bar{X}$  g =  $3.87 \pm 1.86 \mu\text{g g}^{-1}$ ); sin embargo, no se encontraron diferencias significativas entre ellos. En los molares de los donadores de mayor edad la media geométrica de plomo fue más elevada ( $\bar{X}$  g =  $5.81 \mu\text{g g}^{-1}$ ). Los molares de las mujeres tuvieron niveles de plomo más altos que los de los hombres, con diferencias no significativas entre ellos.

---

\* Author whom correspondence should be addressed to, e-mail: barmando@atmosfera.unam.mx

## INTRODUCTION

The determination of lead in human tissue has been of great concern among many researches due to its harmful effects on human health. Lead is toxic as a result of chronic and acute exposure (Cheremisinoff and Cheremisinoff 1993). In many cases, people are unaware of its health effects for a long time; however, when the first symptoms appear the damage might be irreversible, since there is not always a discernible threshold for the dose-effect cause (Graef 1991). The lead level in teeth has been used as an index of accumulation of lead and environmental pollution (Needleman *et al.* 1974, Mackie *et al.* 1977, Cleymaet *et al.* 1991, Bercovitz and Laufer 1992, Srivastava and Srivastava 1992, Bercovitz *et al.* 1993). Several studies have been carried out to determine lead levels in dentine, enamel, and root of erupted and impacted permanent teeth (Shapiro *et al.* 1972, Lappalainen and Knuuttila 1981, Steenhout and Pourtois 1981, Frank *et al.* 1990, Bercovitz and Laufer 1992, Bercovitz *et al.* 1993). However, to the authors' knowledge, measurements of lead concentration in whole fully impacted third molars (inside the bone) have not been made. Determination of lead in non-erupted molars seems to be an appropriate estimate of lead absorbed by individuals exposed to polluted environments. Also, it benefits from the fact that impacted molars are not contaminated from saliva and dental plaque (Shour and Massler 1941). It has been found that lead concentration in dental tissues is related to the donor's age or tooth age (Lappalainen and Knuuttila 1981, Steenhout and Pourtois 1981, Khan-dehar *et al.* 1986, Frank *et al.* 1988, Bercovitz and Laufer 1992, Srivastava and Srivastava 1992, Gil *et al.* 1994).

There are many sources of lead in Mexico City, in the past, about 3 million motor vehicles were the most important source because unleaded gasoline was used for many years (SEMARNAP 1996).

The purpose of this study was to determine lead in whole impacted third molars and to compare lead levels between molar position, age, and gender.

## MATERIALS AND METHODS

### Teeth collection

Fifty-six whole impacted third molars were extracted from people, attending the clinic of maxillofacial surgery of the Faculty of Dentistry, National Autonomous University of Mexico (UNAM). People of both genders between 15 to 28 years old who have been living in the same area since birth were clinically healthy were randomly selected. Each tooth was stored in a plastic bag and sent to the Atmospheric Chemistry Laboratory of the Atmospheric Sciences Center (UNAM) for chemical analysis.

### Sample preparation

All glassware and plasticware was soaked in a 20 % nitric acid solution for 24 hours and then rinsed with deionized water. Each tooth was washed with distilled water and soaked in 25 mL of 10 % v/v sodium hypochlorite solution for 24 hours, followed by rinsing with deionized water and dried at 103 °C to constant weight. Each tooth was transferred into a beaker and digested with 5 mL of concentrated double-distilled nitric acid and 200 µL of hydrogen peroxide. After complete dissolution, the solution was cooled and poured into a 25 ml volumetric flask, and made up to volume with deionized water. Internal quality control was done with deionized water spiked with known quantities of Pb and treated like samples. Recovery was of 108 %.

### Analysis

Lead levels were determined at 283.3 nm by graphite furnace atomic absorption spectrometry with a double beam 932AA GBC instrument coupled with a System 3000 graphite furnace accessory which consist of a GF3000 graphite power supply and a PAL3000 furnace autosampler, both controlled by a computer. A deuterium lamp, for background correction, a boosted discharge hollow cathode lamp (Photron Super lamp) and pyrolytically coated furnace tubes were used.

### Statistical analysis

Tooth lead concentrations followed an approximate lognormal distribution; therefore, geometric means were used. Data were grouped by gender and age. Out of 56 tooth sampled, 27 were female and 29 male. Subjects were divided in three intervals of age: 15 to 19 (N = 21), 20 to 24 (N = 26) and  $\geq 25$  years old (N = 9).

Non-parametric statistical methods were used to estimate whether there were significant differences between the above mentioned variables, since the distribution is approximately lognormal. The Wilcoxon-Mann-Whitney two-tail test (large-sample normal approximation with continuity correction and U test) (Sprent 1989) was applied to compare tooth lead levels between gender and among different molar positions. The one-way Kruskal Wallis test (one-tail test) was used to compare tooth lead concentrations among age intervals. In both tests a  $p \leq 0.05$  was used.

## RESULTS

**Table I** shows third molars lead concentrations. The lead level ranged from 1.1 to 14.2 µg g<sup>-1</sup> in dry teeth with a general geometric mean of  $4.2 \pm 1.7$  µg g<sup>-1</sup>. Despite mandibular molars had higher concentration ( $4.5 \pm 1.6$  µg g<sup>-1</sup>) than the maxillary molars ( $3.9 \pm 1.9$  µg g<sup>-1</sup>), the Wilcoxon-Mann-Whitney test shows non-significant dif-

**TABLE I.** LEAD CONCENTRATION ( $\mu\text{g g}^{-1}$ , DRY WEIGHT) IN THIRD MOLARS

Tooth	N	Geometric mean	Geometric standard deviation	Minimum	Maximum
All third molars	56	4.21	1.74	1.08	14.21
All uppers	26	3.87	1.86	1.08	14.21
All lowers	30	4.53	1.62	1.69	9.96
Right upper	14	3.59	1.94	1.08	11.95
Left upper	12	4.22	1.79	1.91	14.21
Right lower	13	4.71	1.58	2.05	8.56
Left lower	17	4.40	1.68	1.69	9.96

ferences ( $|Z| = 1.21$ ). Left upper molars had higher geometric mean concentration ( $4.22 \pm 1.79 \mu\text{g g}^{-1}$ ) than the right upper molars ( $3.59 \pm 1.94 \mu\text{g g}^{-1}$ ), and right lower molars ( $4.71 \pm 1.58 \mu\text{g g}^{-1}$ ) than the left lower molars ( $4.4 \pm 1.68 \mu\text{g g}^{-1}$ ). No significant differences were found between these teeth ( $U = 72$  and  $104$ , respectively).

**Table II** shows third molars lead concentrations by age and gender. Regarding age, the geometric mean lead concentration for the interval  $> 25$  years old had highest geometric mean concentration followed in order by the intervals from 20-24 and 15-19 years old. The Kruskal-Wallis test ( $H = 9.2$ ) indicated that there are significant differences at least in one interval, therefore, the Wilcoxon-Mann-Whitney test was applied. This test indicated significant differences between the range of 15-19 years old with the other two intervals of age ( $|Z| = 2.17$  and  $2.94$ , respectively).

The geometric mean lead concentration for females was higher than for males (**Table II**), however, a non-significant difference ( $|Z| = 0.43$ ) was found.

## DISCUSSION

Lead concentration found in third mandibular molars was higher than that in third maxillary molars. This is due to the fact that metal is deposited during active dentine mineralization; however, there is a measurable uptake of trace elements by mature dentine (Posner and Tannenbaum 1984). Furthermore, the third mandibular mo-

lar pulp is larger than that of the maxillary, possibly because the former can absorb more lead and calcify before the maxillary molars do (Moyers 1992); however, other causes could also exist.

Determination of lead in non-erupted molars seems to be an accurate estimate of the lead acquired by absorption by subjects from the polluted environment, it also has the advantage that molars impacted are not contaminated from saliva and dental plaque (Schour and Massler 1941).

Lead is an accumulative function of early exposure (Steennhout and Pourtois 1981) and occurs during dental hard tissue formation before eruption and until development completion (Bercovitz and Laufer 1992). The results of this study support the above assumption since significant differences between age and lead levels were found, corresponding to higher concentrations in older teeth (**Table II**). These differences are in agreement with the results reported by Lappalainen and Knuutila (1979), Steennhout and Pourtois (1981), Frank *et al.* (1990), and Bercovitz and Laufer (1991) but with erupted teeth where lead concentration was directly proportional to subject's age. Therefore, a comparison would not be useful. These results support the theory that lead accumulation depends on donor's age and that it is not related to the developmental stage of the teeth (Purchase and Fergusson 1986, Bercovitz and Laufer 1992).

Although females showed a maximum lead concentration ( $14.21 \mu\text{g g}^{-1}$ ), no significant differences in lead concentration between males and females' impacted mo-

**TABLE II.** LEAD CONCENTRATION ( $\mu\text{g g}^{-1}$ , DRY WEIGHT) IN THIRD MOLARS BY AGE AND GENDER

Variables	N	Geometric mean	Geometric std. deviation	Minimum	Maximum
Age (yr)					
15-19	21	3.19	1.64	1.08	7.93
20-24	26	4.71	1.76	1.97	14.21
$\geq 25$	9	5.81	1.44	3.87	9.96
Gender					
Female	27	4.30	1.88	1.08	14.21
Male	29	4.13	1.61	1.83	9.96

lars were found. Lead determinations made in different erupted teeth by other researchers showed similar results, meaning that gender did not influence tooth lead levels (Lappalainen and Knuuttila 1979, Steenhout and Pourtois 1981, Bercovitz and Laufer 1991).

Lead concentrations were compared with the results published by Bercovitz and Laufer (1992) and Bercovitz *et al.* (1993). In this study, the following arithmetic mean concentrations were obtained:  $3.58 \pm 1.79$ ,  $5.48 \pm 3.18$ , and  $6.18 \pm 2.37 \mu\text{g g}^{-1}$  for age ranges of 15-19, 20-24, and  $\geq 25$  years old, respectively. Bercovitz and Laufer (1992) reported arithmetic mean concentrations of  $1.57 \pm 0.34$  for the age range of 19-29 years old. Bercovitz *et al.* (1993) reported  $1.61 \pm 0.81$  and  $2.86 \pm 1.98 \mu\text{g g}^{-1}$  for the age ranges of 14-20 and 21-30 years old, respectively. Although lead concentrations obtained in this study were higher, they were determined in dry whole impacted teeth, while the above mentioned authors analyzed lead concentrations in dry root dentine of impacted teeth. Therefore, it is not possible to compare our results with those they obtained.

## CONCLUSIONS

Mandibular molars presented higher concentrations than maxillary molars, probably because third mandibular molars are larger than third maxillary molars. This could mean that the former absorb more lead and, moreover, they begin their calcification earlier than the latter. Although third molars lead concentrations were higher in females than in males, no significant differences were found, therefore, third molars lead concentrations do not seem to depend on gender. Higher lead concentrations were observed in elderly individuals' molars, indicating that lead accumulation depends on the donor's age.

## ACKNOWLEDGEMENTS

This study was partially sponsored by the Dirección General de Asuntos del Personal Académico (PAPIIT), National Autonomous University of Mexico, Project IN209996. We would like to thank Ma. del Carmen Torres B. for her help in the sample preparation, and Hugo Padilla G. for proofreading the English manuscript.

## REFERENCES

- Bercovitz K. and Laufer D. (1991). Age and gender influence on lead accumulation in root dentine of human permanent teeth. *Archs. Oral Biol.* *36*, 671-673.
- Bercovitz K. and Laufer D. (1992). Systemic lead absorption in human tooth roots. *Archs. Oral Biol.* *37*, 385-387.
- Bercovitz K., Helman J., Peled M. and Laufer D. (1993). Low lead level in teeth in Israel. *Sci. Total Environ.* *136*, 135-141.
- Cleymaet R., Bottenberg P., Slop D., Clara R. and Coomans D. (1991). Study of lead and cadmium content of surface enamel of schoolchildren from an industrial area in Belgium. *Community Dent. Oral Epidemiol.* *19*, 107-111.
- Cheremisinoff P.N. and Cheremisinoff N.P. (1993). Lead: a guidebook to hazard detection, remediation, and control. PTR Prentice Hall, Englewood Cliffs, New Jersey, p. 13.
- Frank R.M., Sargentini-Maier M.L., Leroy M.J.F. and Turlot J.C. (1988). Age-related lead increase in human permanent teeth demonstrated by energy dispersive X-ray fluorescence. *J. Trace Elem. Electr. Health Dis.* *2*, 175-179.
- Frank R.M., Sargentini-Maier M.L., Turlot J.C. and Leroy M.J.F. (1990). Comparison of lead levels in human permanent teeth. *J. Dent. Res.* *69*, 90-93.
- Gil F., Perez M.L., Facio A., Villanueva E., Tojo R. and Gil A. (1994). Dental levels in the Galician population, Spain. *Sci. Total Environ.* *156*, 145-150.
- Graef J. (1991). Intoxicación por metales pesados. In: *Principios de Medicina Interna de Harrison* (T.R. Harrison, Ed.). McGraw-Hill Interamericana, México, 2841-2842.
- Khandehar R.N., Raghunath R. and Mishra U.C. (1986). Lead levels in teeth of an urban Indian population. *Sci. Total Environ.* *58*, 231-236.
- Lappalainen R. and Knuuttila M. (1979). The distribution and accumulation of Cd, Zn, Pb, Cu, Co, Ni, Mn and K in human teeth from five different geological areas of Finland. *Archs. Oral Biol.* *24*, 363-368.
- Lappalainen R. and Knuuttila M. (1981). The concentrations of Pb, Cu, Co, and Ni in extracted permanent teeth related to donor's age and elements in the soil. *Acta Odontol. Scand.* *39*, 163-167.
- Mackie A.C., Stephens R., Townshend A. and Waldron H.A. (1977). Tooth lead levels in Birmingham children. *Arch. Environ. Health* *32*, 178-185.
- Moyers R.E. (1992). Manual de ortodoncia. Médica Panamericana, Buenos Aires, Argentina, pp. 115-145.
- Needleman H.L., Davidson I., Sewell E.M. and Shapiro I.M. (1974). Subclinical lead exposure in Philadelphia schoolchildren: identification by dentine lead analysis. *N. Engl. J. Med.* *290*, 245-248.
- Posner A.S. and Tannenbaum P. (1984). The mineral phase of tooth. In: *Dentin and Dentinogenesis* (A. Linde, Ed.). CRC Press, Boca Raton, pp. 17-36.
- Purchase N. and Fergusson J. (1986). Lead in teeth: the influence of the type and the sample within a tooth on lead levels. *Sci. Total Environ.* *52*, 239-250.
- Schour I. and Massler M. (1941). The development of human dentition. *J. Am. Dent. Assoc.* *28*, 1153-1160.
- SEMARNAP (Secretaría del Medio Ambiente, Recursos Naturales y Pesca) (1996). Programa para mejorar la calidad del aire en el Valle de México, México D. F.
- Shapiro I.M., Needleman H.L. and Tuncay O.C. (1972). The lead content of human deciduous and permanent teeth. *En-*

- viron. Res. 5, 467-470.
- Sprent P. (1989). Applied nonparametric statistical methods. Chapman and Hall, London-New York, pp. 92-93.
- Srivastava M.M., Srivastava S. and Vaid A. (1992). Tooth lead concentration as an indicator for environmental lead pollution in Agra City, India. Bull. Environ. Contam. Toxicol. 48, 334-336.
- Steenhout A. and Pourtois M. (1981). Lead accumulation in teeth as a function of age with different exposures. British. J. Ind. Med. 38, 297-303.