Bull. Environ. Contam. Toxicol. (1993) 50:724–729

Bulletin of Environmental Contamination and Toxicology

Carious Teeth as Indicators to Lead Exposure

Klara Bercovitz and D. Laufer

Department of Oral and Maxillofacial Surgery, Rambam Medical Center, Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, 31096, Israel

Lead accumulated in teeth is used as an index to environmental pollution as well as to body burden. In most studies only sound teeth were analyzed and carious ones were excluded (Lappalainen and Knuuttila 1979; Grobler et al. 1985; Khandekar et al. 1986). Some used only carious teeth as they are more available (Stewart 1974) while others used both sound and carious teeth (Altshuller et al. 1962; Needleman et al. 1972; Paterson et al. 1988).

The role of lead on the prevalence of dental caries or of caries affecting lead accumulation is controversial. Some pointed to a positive association between lead and caries (Buttner 1969; Brudevold et al. 1977; Davis et al. 1987), while others could not demonstrate any significant correlation (Anderson et al. 1979; Anttila 1986). Paterson et al. (1988) did not reach statistical significance, but mentioned a tendancy to higher lead level in carious teeth. Despite the unclearity as to the effect of caries on lead accumulation they used together sound, carious and filled teeth.

Our aim is to analyze lead level in carious teeth and to find out whether they can be used as monitors to environmental pollution as well as to body burden with or without sound teeth. This will enable the use of a larger population in any study especially in studies involving adults where no teeth shedding occurs and most extracted teeth are carious.

MATERIALS AND METHODS

Two hundreds and seventeen permanent teeth were examined. Of these 173 carious or filled teeth were extracted from 173 different people, aged 15 - 77yr. More than half of them were wisdom teeth, but all other

Send reprint requests to K. Bercovitz at the above address.

types were used. The teeth were divided into 7 age groups according to the donor's age. The last age group consist only of a few teeth, as it is rare to find old people (age 71+) with their own teeth.

From 22 persons a pair of teeth were extracted: one was sound and the other carious or with filling. As in this group no comparison was made between individuals, only between the pair: sound and carious teeth, the donor's age was not significant.

The degree of caries differed from a small damaged area to a very large infected area. Abrasive teeth were included too. Teeth with root canal treatment were excluded.

All teeth were cut at their cervices with a dental drill, in order to remove enamel and caries. The cement layer was also removed with a dental drill so that the lead content of the root dentine alone could be determined. These roots were dried at 105°C overnight, digested in concentrated nitric acid and diluted to 25 ml with deionized water.

One-way-ANOVA was applied to evaluate differences in lead level between sound and carious teeth of different people. A paired t-test was applied between the sound and carious teeth of the same subject.

Most of the teeth donors were permanent residents in northern Israel. Most of them live there from their birth or almost from it. The examined population was not occupationally exposed. Moreover, there are only several factories using lead in the entire area.

The tooth roots were analyzed for lead in a Varian (Spectra 40) graphite furnace atomic absorption spectrophotometer (AAS). The setting of the AAS and the furnace was described previously (Bercovitz and Laufer 1991a).

RESULTS AND DISCUSSION

Lead levels in carious teeth of men and women are given in Tables 1 - 2, respectively. Lead levels ranged between 0.61 - 36.46 μg/g dry dentine (minimum and maximum values). Average lead level ranged between 3.09 - 26.03 μg/g, according to the donor's age. The results show a significant increase in lead level with the donor's age in most age groups in both genders ($P<0.05$). Statistic analysis was not performed between the last two age groups of males, as the last one (71 - 77) is too small ($n = 2$). No significant difference exists between lead levels of men and women in the same age group, except at the third one e.g. age 31 - 40 yr.

Table 1. Lead level in roots of carious teeth of males (μg/g dry dentine ± S.D.)

Age	Lead level		n
	Average	range	
15 - 20	3.09 ± 2.25a	1.06 - 7.51	9
21 - 30	4.35 ± 3.30a	1.21 - 13.29	15
31 - 40	7.26 ± 4.18b	3.05 - 17.56	16
41 - 50	12.24 ± 5.70c	5.82 - 25.82	14
51 - 60	17.33 ± 6.29d	9.73 - 32.95	16
61 - 70	19.10 ± 6.80d	11.63 - 24.48	6
71 - 77	20.25 ±10.75*	12.65 - 27.85	2

n - number of teeth, from different persons.
Values with different letters - significant differences between the groups ($P<0.05$).
Values with the same letter - no significant differences between the groups ($P>0.05$).
* - n is too small to perform statistics.

Table 2. Lead level in roots of carious teeth of females (μg/g dry dentine ± S.D.)

Age	Lead level		n
	Average	range	
15 - 20	3.63 ± 2.12a	0.61 - 6.21	6
21 - 30	3.16 ± 1.97a	0.90 - 8.42	26
31 - 40	4.62 ± 1.45b	2.40 - 6.83	16
41 - 50	9.25 ± 6.45c	2.68 - 25.97	21
51 - 60	16.06 ± 7.92d	6.38 - 34.31	12
61 - 70	23.78 ± 5.25e	13.78 - 33.23	11
71 - 77	26.03 ±10.37e	13.45 - 36.46	5

n - number of teeth, from different persons.
Values with different letters - significant differences between the groups ($P<0.05$).
Values with the same letter - no significant differences between the groups ($P>0.05$).

Lead levels of men and women were pooled in each age group (Table 3) and then a significant difference in lead level was obvious between the age groups, except the extreme groups. The regression line for both genders is $y = 0.43x-7.63$ (y = lead level, x = donor's age) $r^2=0.64$.

Comparison between pairs of carious and sound teeth from the same person revealed no significant difference between them (Table 4). The same result was noted when lead level in carious teeth from different people were compared with lead level of sound teeth analyzed previously (Table 3).

Table 3. Lead level in roots of carious and sound teeth of both genders (μg/g dry dentine ± S.D.).

Age	Lead level in carious teeth	(n)	Lead level in sound teeth	(n) @
15 - 20	3.31 ± 2.14	(15)a	1.61 ± 0.81	(47)f
21 - 30	3.59 ± 2.56	(41)a	2.86 ± 1.98	(79)a
31 - 40	5.94 ± 3.35	(30)b	6.41 ± 3.80	(24)b
41 - 50	10.45 ± 6.25	(35)c	7.99 ± 3.41	(19)c*
51 - 60	16.79 ± 6.92	(28)d	20.85 ± 9.31	(8)d
61 - 70	22.12 ± 6.08	(17)e	25.72 ±14.84	(3)e
71 - 77	24.38 ± 9.94	(7)e		

n - number of teeth, from different individuals.
Values with different letters - significant differences between the groups ($P < 0.01$)
Values with the same letter - no significant differences between the group ($P > 0.05$).
* - No significant difference between the group above.
@ - Based on Bercovitz et al. (1992)

Table 4. Lead level in roots of pairs of teeth from the same person (μg/g dry dentine ± S.D.).

	Lead level in sound teeth	Lead level in carious teeth
Average	10.95 ± 9.11	11.85 ± 9.21
Range	1.24 - 32.72	1.49 - 33.37

22 pairs of teeth were analyzed. $P > 0.05$.

The filling of the teeth did not contain lead; thus, no attempt was made to distinguish between carious teeth which have never been filled and those with filling. Tooth type does not affect the lead level of permanent teeth of adults at a low level of accumulation (Bercovitz and Laufer 1991b); thus, all kinds of teeth were used in this research.

A significant positive correlation was found between Pb level in carious teeth and the donor's age in a non occupationally exposed population. The same correlation exists when dealing with sound teeth. Moreover, sound and carious teeth show the same annual accumulation (Bercovitz and Laufer 1991c).

Annual accumulation of lead in both sound and carious teeth is relatively low. The main source of pollution is leaded gasoline and as motorization rate (number of vehicles per 1,000 inhabitants) is low (Motor vehicles 1988), the annual accumulation is low. Other sources

had a minor effect, if any. In Israel the water is hard and their lead content is very low. Nowadays most paints do mot contain lead, except primary ones. There are only a few battery plants or other factories using lead (e.g P.V.C) and lead smelters do not exist here.

No significant differences were found between the lead levels in carious teeth from men and women in any particular age group in northern Israel, except in the third age group. Lead level of females in the third group seems very low comparable to the previous and the next age group (Table 2). As no other differences exist between lead levels of the two genders, these levels were pooled at each age group. Again, the same insignificant effect of the gender was seen in sound teeth (Bercovitz et al. 1992).

Brudevold et al. (1977) assumed that lead from the oral cavity enters into the hydroxyapatite of the tooth through the carious area. Even if it is true, we assume that lead did not penetrate deeper than the carious area. This is concluded from the fact that lead level in carious teeth is the same as in sound teeth of different persons (Table 4) as well as of the same person (Table 3). Thus lead accumulation in roots of carious teeth is only systemic. Systemic accumulation was observed previously in sound teeth (Bercovitz and Laufer 1992).

As a consequence of systemic lead accumulation in roots of carious teeth, similar accumulation as in sound teeth, same dependence on the donor's age and the same independence on the gender, they can be used as indicators to body burden as well as to environmental pollution. Permanent carious teeth are much more available than permanent sound teeth, thus a larger population can be enrolled in any study. Carious teeth can be used together with sound teeth and enlarge the sample size. Moreover, as teeth do not undergo remodelling processes and lead release from them is negligible (Steenhout 1982), they provide an excellent pathway of removal of a potential pollutant from the body.

Acknowledgment. We gratefully acknowledge the analytical support extended us by IMI Institute for Research & Development of Israel Chemicals Ltd. The analytical work required for this study was performed by their Analytical Department.

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Received May 21, 1992; accepted December 2, 1992.