

Lead concentrations in maternal and umbilical cord blood in areas with high and low air pollution

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Summary

The lead concentrations in maternal and umbilical cord blood were determined in 50 parturient women at delivery. Twenty-five lived in agricultural areas with low air pollution and 25 lived in urban areas with high air pollution. The mean lead concentrations (mean \pm SD) in maternal and umbilical cord blood and the correlation coefficient of mothers from urban areas with high air pollution were 37.2 ± 4.7 ng/ml, 20 ± 3.4 ng/ml and $r=0.57$, respectively. The mean lead concentrations in maternal and umbilical cord blood and the correlation coefficient of mothers from agricultural areas with low air pollution were 20.5 ± 5.6 ng/ml, 12.9 ± 3.6 ng/ml and $r = 0.70$, respectively.

Our results show that the difference in mean lead concentration between the blood of mothers both from urban and agricultural areas and the blood from the umbilical cords of their newborns was statistically significant ($p<0.001$). The factors that control the transfer of lead from the mother's blood to the fetus are the quantity of the element in the mother's blood and the placenta itself which has a dynamic protective function that is amplified when maternal blood lead levels are raised.

Key words: Lead; Umbilical cord; Pregnancy.

Introduction

Lead is a heavy metal commonly found in the environment. Lead is found in paint products, ceramic products and in soil near abandoned industrial areas. Water transported through lead or lead soldered pipes contains some lead with high concentrations found in water that is weakly acidic.

Exposure to lead from any of these sources by infection, inhalation or direct contact can cause significant toxicity. Lead expresses its toxicity by several mechanisms. Hence, exposure is similar for the fetus and the mother [1, 2]. Lead also crosses the blood-brain barrier [1]. According to the available data the central nervous system is sensitive to the toxic effects of lead and consequently prenatal exposure to lead may damage the brain of the fetus [1, 3]. The purpose of this study was to determine the concentrations of lead in maternal and fetal blood and the correlation in terminal pregnancies from agricultural areas with low air pollution and industrial areas with high air pollution.

Material and Methods

Twenty-five parturient women aged 18 to 41 from industrial areas with high air pollution (group A) and 25 parturient women aged 17 to 30 from agricultural areas with low air pollution (group B) were investigated. The characteristics of the women in group A and in group B are shown in Table 1. None of them reported any pathological disorder during pregnancy nor had they a history of any worth-mentioning disease. The gestational age of the parturients from group A varied between 35 and 41

weeks with a mean age of 38.8 ± 1.7 weeks. The gestational age of the parturients from group B varied between 36 and 41 weeks with a mean age of 39.6 ± 1 weeks.

Twenty-two of the parturients from group A had a normal labor and in 3 of them a cesarean section was performed; the mean weight of the newborns was 3100 ± 430 gr. Twenty-three of the parturients from group B had a normal labor and in 2 of them a cesarean section was performed; the mean weight of the newborns was 3360 ± 400 gr.

Lead concentrations were determined by atomic absorption spectrophotometry with a Perkin-Elmer Model 603 atomic absorption spectrophotometer as previously described [4]. 10 μ l of blood was pipetted into a nickel cup and dried on a tray in the oven at 140°C for 30 seconds. After the flame of the ignited sample had disappeared, the cup was pushed 3 mm below the center of the silica tube for atomization. The integrated peak area (6 seconds) was recorded at the lead resonance line 283.3 nm, with background correlation.

Student's *t* test, chi-square and regression analysis were used for the statistical analysis of the data.

Table 1. — *Characteristics of women in areas with high air pollution (group A) and in areas with low air pollution (group B)*

	Group A	Group B	p
Maternal age	26.5	26.3	NS
Gestational age at the time of the study	38.8 ± 1.7	39.6 ± 1	NS
Previous pregnancies (No)			
I	12	11	NS
II	9	9	NS
III	4	5	NS
Smoking	2	1	NS
Consumption of red wine (2-6 times per week)	1	1	NS
Consumption of milk/yogurt (2-6 times per week)	20	19	NS

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Table 2. — Results

	Group A (mean±SD)	Group B (mean±SD)	p
Maternal blood lead levels (ng/ml)	37.2±4.7	20.5±5.6	<.001
Cord blood lead levels (ng/ml)	20±3.4	12.9±3.6	<.001
Gestational age at delivery	38.8±1.7	39.6±1	NS
Birth weight	3100±430	3360±400	NS

Results

In mothers from group A, the mean (±SD) whole blood lead concentration in maternal blood was 37.2±4.7 ng/ml and in umbilical cord blood 20±3.4 ng/ml and the correlation coefficient was $r=0.57$. In mothers from group B the mean lead concentration in maternal blood was 20.5±5.6 ng/ml and in umbilical cord 12.9±3.6 ng/ml and the correlation coefficient was $r=0.70$ (Table 2).

There is a statistically significant difference ($p<.001$) in mean blood lead concentration between mothers from group A and mothers from group B. There is a statistically significant difference ($p<.01$) in mean blood lead concentration between mothers from group A and the umbilical cord of their infants. Correlation coefficient $r=0.57$.

There is a statistically significant difference in mean blood lead concentration between mothers from group B and their newborns. Correlation coefficient $r=0.70$.

The difference of lead concentration in the umbilical cord blood between mothers from industrial areas and newborns from agricultural areas is statistically significant ($p<.001$).

Discussion

Blood lead levels were lower than those reported in previous studies [4]. The concentration of lead in the blood of parturients from urban areas with high air pollution was higher than that of parturients coming from agricultural areas with air pollution. A positive correlation was found between the blood lead level and gestational week. This increase is probably related to the normal rise in hematocrit and hemoglobin levels in blood in the last quarter of gestation since lead is found in erythrocytes in 90% of parturients [5].

There was no difference in gestational age at delivery between the two groups and we did not find any significant difference in birth weights. In the literature, adverse effects (e.g. reduced gestational age, decreased birth weight) have been also reported [6].

Blood lead levels influenced by several factors such as place of residence, smoking, employment at a smelter and wine consumption. In our study the only difference between the two groups was the place of residence. In previous studies, lead concentrations in umbilical cord blood were significantly correlated with those in the

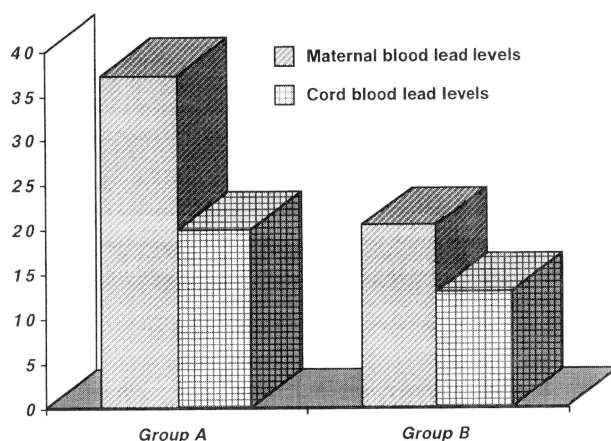


Figure 1. — Lead concentrations in maternal and umbilical cord blood in areas with high (group A) and low air pollution (group B).

mother's blood which were 80% to 87% of the latter [7, 8]. Thus, it is obvious that lead freely passes through the placenta even at substantially lower levels [7].

In our study, statistical analysis showed that lead concentrations in umbilical cord blood correlated with lead concentrations in mother's blood. The correlation coefficient from urban areas with high air pollution had a border significance ($r=0.57$), while there was a strongly significant correlation for agricultural areas with low air pollution ($r=0.70$).

As far as the placenta is concerned, it is the main factor that controls lead levels in the fetus. The element's concentration in mother's blood is another one.

The placenta plays a dynamic but not a statistically protective role which is amplified when lead levels in maternal blood are higher.

It seems that there are mechanisms or perhaps receptors in the placenta that act inhibitory in lead transfer from the mother to the fetus and their activation depends on raised lead levels in maternal blood. It seems also that these mechanisms act quantitatively and that they may be influenced by other unknown factors, since the absolute value of lead in the umbilical cord does not, as we have shown, appear elevated in proportion to lead elevation in the maternal blood.

Therefore, further studies regarding the effects of lead, both on the fetus and on the placenta, are warranted.

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