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Assessment of Lead Levels in Maternal and Cord Blood at Jaunpur District of Uttar Pradesh, India

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Abstract

Aims: To determine the concentration of blood Lead in venous blood of mothers and cord blood of their respective neonates living at Jaunpur district of eastern Uttar Pradesh, India.

Methods: Pregnant women admitted to the District Hospital, Jaunpur were selected for the study. 57 blood samples were collected from pregnant women (maternal blood) before delivery and from their respective neonates (cord blood). Blood samples were preserved in disodium EDTA vials and stored at 4°C until analysis. Samples were transported to toxicology laboratory, Department of Forensic Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India for quantitative estimation of Lead with the help of Atomic Absorption Spectrophotometer.

Results: The maternal and cord blood Lead levels was highest (15.23±1.5 and 12.39±1.91 μg/dl, respectively) in maternal age group of 31- 35 years while the lowest levels (6.69±2.93 μg/dl and 4.03±1.57 μg/dl respectively) in maternal and cord blood were observed in age group of less than 20 years. The concentration was higher in maternal blood than cord blood in women of all age groups.

Conclusion: The positive correlation between lead levels in maternal and cord blood found in the study shows the transport of lead from mother to fetus during pregnancy therefore, a careful analysis of a mother's environment is needed to reduce the risk of prenatal exposure to lead. Therefore, attempts should be done to lessen exposure of lead as environmentally toxic pollutant.

Keywords: Lead, pregnant women, cord blood, fetus

Introduction

In polluted environment pregnant women is a potential source of lead intoxication for babies during prenatal development and her social background can influence the concentration of lead in prenatal development of neonates. Lead (Pb) is not necessary for any physiologic function in the body, and thus is a poisonous element for living organisms. It is taken up via contaminated air, dust and food and accumulates in the body, primarily in the bones. The biologic half-life of lead is quite long in the body.[1-3] Some sources of infant Blood Lead (BPb) reflect direct maternal exposure, such as occupational lead exposure, exposure to lead paint, or use of lead glazed ceramics.[4]

During pregnancy and lactation when there is an increased demand for calcium, lead is released from bones in the mother and gets transferred to fetus or nursing infant. Previous studies on lead concentrations in pregnant women generally showed an increase in BPb levels during the third trimester, which was attributed to increased bone resorption to meet the calcium requirements of the developing fetus.[5-12] Other studies also demonstrated that extra lead is released from the maternal skeleton during pregnancy and

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lactation in cynomolgus monkeys and in humans.[13-18]

Several other studies have reported a positive association between maternal BPb concentration and the risk of spontaneous abortion.[19-21] Lead poisoning is a less common but serious health threat[22-23] especially higher lead levels or exposure over longer periods can cause irreversible damage to the nervous systems and the kidneys. During pregnancy, even lower lead levels are of serious concern because of their adverse effects on the fetus, including developmental delays, low birth weight, and miscarriage.[23-24]

Methods

The present study was conducted at District Hospital, Jaunpur, Uttar Pradesh, India. The data were collected over one year period starting from January 2008 to December 2008. Pregnant women at the age of 18 to 35 years from Jaunpur region were sampled randomly. All subjects have been residing for at least 2 years at that location with no known occupational exposure to lead or other occupational hazards. Eligible subjects were women who were admitted for delivery in study hospital and were expected to deliver a singleton fetus at completed term (37–42 weeks of gestation). Mothers were informed about the nature and the aim of the present work, and they agreed to participate in the study and signed a letter of informed consent.

For measurement of BPb, 5 ml of venous blood was taken after carefully cleaning the skin at the venepuncture site. Blood samples were taken from the antecubital vein of pregnant women (subject) while delivering. Umbilical cord blood was sampled immediately after cutting off the cord. The blood was collected in acid-washed polypropylene vials containing K2 EDTA as anticoagulant and stored at 4°C until analysis.

Prior to the quantitative estimation of lead in pregnant woman, blood was acid digested with a mixture of HNO_3:$HClO_4$ (6:1) for 24 hours. During the process each sample is digested in triplicate to avoid the chance of error during final estimation. The digestion was done in fuming chamber with all due necessary precautions. Method of Awasthi et al. were adopted during digestion and analysis of lead in blood samples.[25] Analysis of BPb was performed at the laboratory of the Department of Forensic Medicine, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India. Analysis was done with the help of Atomic Absorption Spectrophotometer (AAS). Series of working standards 1μg/dl, 2μg/dl, 5μg/dl and 10μg/dl were prepared as per the instruction manual of Instrument.[26] The sensitivity of the instrument for lead was 1.0μg/dl.

Statistical analysis was performed on the 57 subjects with complete BPb data on the entire data set. The goal of the analysis was to determine significant changes and significant difference in lead level during the pregnancy. Student's t test was used to test statistical significance in different age groups of pregnant women and BPb level. The analysis of variance (ANOVA) was used to assess significant changes in maternal blood lead during pregnancy to assess the variables that were significantly associated with lead. P value less than 0.01 is considered as significant.

Results

Table 1 describes that the concentration of BPb was higher in maternal blood in comparison to cord blood in all age groups. In maternal blood the concentration was found maximum (15.23±1.5μg/dl) within the age group of 31-35 years and minimum (6.69±2.93 μg/dl) in the age group of <20 years. Similar pattern was observed in cord blood with maximum (12.39±1.91μg/dl) and minimum (4.03±1.57μg/dl) concentration in age group of 31-35 and <20 respectively.

It was observed from table 2 that of the total 57 selected subjects 49 (85.96%) had Hb level ≤9 g/dl while only 8 (14.04%) subjects were found with Hb >9g/dl. It was also observed that 33 subjects (57.89 %) had maternal BPb concentration >10 μg/dl. Similar pattern was observed in cord blood with 18 subjects (31.58%) having BPb concentration >10 μg/dl. A direct correlation was observed between the haemoglobin level and BPb concentration. Subjects who had Hb level >9 g/dl also had BPb level within permissible limit of 10 μg/dl.

Table 1. Distribution of Maternal and Cord BPb levels among Pregnant Women

Age (Years)	No. of Samples	Maternal BPb Level (Mean ±SD) μg/dl	Cord BPb levels (Mean ±SD) μg/dl	p value
<20	6	6.69±2.93	4.03±1.57	.0003
20-25	17	8.85±3.46	5.28±2.89	.0015
26-30	30	11.74±3.6	8.69±3.39	.0006
31-35	4	15.23±1.5	12.39±1.91	.0023

Table 2. Distribution of Maternal and Cord BPb according to Hb

Hb level (g/dl)	No. of Samples	Maternal BPb		Cord BPb	
		< 10 μg/dl	> 10 μg/dl	< 10 μg/dl	> 10 μg/dl
≤9	49	16 (8.38±1.56)	33 (13.11±2.0)	31 (6.16±2.21)	18 (11.87±1.37)
>9	8	8 (4.16±2.83)	–	8 (2.26±1.66)	–
	p value		<.0001		<.0001

Table 3. Distribution of Maternal and Cord BPb by Residential Area

Residence	No. of samples	Maternal BPb		Cord BPb	
		< 10 μg/dl	> 10 μg/dl	< 10 μg/dl	> 10 μg/dl
Urban	19	18 (6.24±2.92)	1 (10.39)	17 (3.35±1.92)	2 (10.42±0.29)
Rural	38	6 (9.18±0.87)	32 (13.26±2.0)	20 (7.04±1.76)	18 (11.88±1.39)
p value			<.0001		<.0001

Table 4. Distribution of Maternal and Cord BPb according to Gravida and Abortion

Gravida	No of samples	BPb level < 10 μg/dl		BPb level > 10 μg/dl		p value
		Maternal BPb	Cord BPb	Maternal BPb	Cord BPb	
1	21	18 (6.82±2.58)	21 (4.14±1.99)	3 (10.68±0.26)	-	<.0001
2	16	6 (7.44±3.80)	14 (6.32±2.37)	10 (11.47±0.93)	2 (10.65±0.70)	<.0001
3	13	2 (9.21±0.83)	4 (8.88±0.17)	11 (14.25±1.23)	9 (11.77±0.77)	<.0001
4	7	-	1 (10.0)	7 (15.28±1.63)	6 (12.79±1.72)	0.014
Abortion/ miscarriage						
0	38	24 (6.97±2.86)	36 (5.15±2.45)	14 (11.49±1.10)	2 (10.99±0.13)	<.0001
1	14	2 (9.21±0.83)	4 (9.01±0.78)	12 (14.28±1.48)	10 (11.83±1.50)	<.0001
2	5	1 (9.82)	1 (8.62)	4 (15.91±0.88)	4 (12.69±1.42)	0.003

Table 3 depicted that mean lead level in Maternal and cord blood was higher in rural women (13.26±2.0μg/dl) than urban (11.88±1.39 μg/dl). It was also observed that majority of the rural women (84.21%) had maternal BPb concentration more than 10 μg/dl in comparison to urban women (5.26%). Similar pattern was observed in cord blood with 18 women (94.73%) having mean concentrations more than 10 μg/dl (11.88±1.39μg/dl) in rural region. Only two women (10.52%) from urban area had cord BPb concentration more than 10μg/dl. Majority of the women living in urban area (94.73%) were found with maternal blood concentration less than 10 (6.24±2.92μg/dl) in comparison to rural women (15.78). Similar pattern was observed in cord blood. Table 4 described that maternal and cord BPb level was found maximum (15.28±1.63 μg/dl and 12.79±1.72μg/dl respectively) in all those women who had gravida 4. The concentration of lead level increased with the increase of gravida. In women with 1 gravida, the maternal BPb concentration was lowest (6.82±2.58μg/dl). It was also observed that there is large difference in BPb concentration both in maternal and cord blood

in women having no previous history of abortion and this difference decreases with the increase of number of previous abortions. The maternal concentration was found maximum (15.91±0.88µg/dl) in women having at least 2 abortions and lowest in women who had no history of previous abortion. Similar pattern was seen in cord blood.

Discussion

It was concluded (table 1) that lead concentration was higher in maternal blood than cord blood in women of all age groups. This concentration increases with the age of women with maximum concentration in age group of 30-35 years. The increase in BPb levels with age may be due to the increase of total lead burden in extreme age.

In a similar study Raghunath et al determined Heavy metal concentrations in maternal and cord blood samples collected from mothers in the age group 20-25 years with full-term neonates 37-40 weeks. The levels of Pb, Cd, Cu and Zn in maternal and cord blood samples were 6.4, 0.07, 108.5, 633.5µg/dl and 5.1, 0.06, 51.1, 252.7µg/dl, respectively. The concentrations of these elements were found to be high in mother's blood as compared to the cord blood.[27]

Moura et al designed their study to determine variations in BPb levels during pregnancy. A statistically significant increase in BPb levels at a 5% level was observed between the first and third trimester. The median BPb levels for the first, second and third trimester were 5.1µg/dl, 5.9µg/dl, and 8.25µg/dl respectively. It is concluded that there was a significant increase in BPb concentration during third trimester of pregnancy.[28] these results are in accordance with our study having the maximum concentration of blood lead in third trimester.

Srivastava et al determined the lead levels in mothers and neonatal blood. Both maternal and cord BPb levels were significantly higher. Significantly, the mean cord BPb level was > 10µg/dl, which is greater than Centers for Disease Control's intervention level, in 54% of newborns. A good correlation between maternal and cord BPb levels confirmed the transfer of lead from mother to the fetus. The concentrations of Pb, were found in the ratio between cord blood and maternal approximately 0.80. A strong correlation was observed by them between the maternal and cords BPb level during their study.[29] Yazbeck et al evaluated current prevalence of lead burden in neonates, and seeks for sources of maternal and fetal intoxication. The mean cord BPb concentration was 23.2 µg/l. eighteen neonates (1.8%) had lead levels above 100µg/l.[30]

It was concluded from table 2 that BPb concentration was higher in the women having haemoglobin (Hb) level equal to or less than 9. A direct relation (p=<.001) was observed in Hb and total BPb burden which decreases with higher Hb. This may be due to the iron (Fe) supplementation to the women because Fe decreases the release of bone lead in blood stream. The BPb concentration was higher in the women residing in rural area (table 3). This may be due to the low intake of calcium and iron rich diet during pregnancy. The higher concentration of BPb in rural women may also be correlated (p=<.001) with low Hb values.

Wang et al did a cross-sectional investigation on maternal and umbilical BPb levels in an urban area, an industrial town and a rural area of middle China. Blood samples from 89 mothers during delivery, from the umbilical cords were collected. The geometric mean of lead levels in blood of pregnant women at delivery both in the rural area (74.4µg/l, range: 35.2 - 245.6µg/l) and industrial town (65.9µg/l, range: 20.0 -172.0µg/l) were higher than in the urban region (54.3µg/l, range: 27.9 -187.0µg/l). The BPb level of pregnant women was lower in urban, but higher in rural areas. The geometric mean for lead level in umbilical cord blood was also significantly higher in rural (84.1µg/l, range: 28.0 - 185.0µg/l) than in the other areas (53.5µg/l, range: 23.5 -156.7µg/l in the urban; 60.1µg/l, range: 12.5 - 168.3µg/l in the industrial town).[31]

Hertz-Picciotto et al investigated the pattern of BPb during pregnancy in a cohort of 195 women at Magee-Women Hospital in Pittsburgh, Pennsylvania, by week 13 of pregnancy. Results indicate that during pregnancy BPb levels increase with age, smoking, lower educational level, and African-American race and decrease with history of breast feeding and higher intake of calcium. Additionally, interactions were found between time since last menstrual period and both maternal age and calcium. Specifically, older mothers showed steeper increases in BPb concentrations during the latter half of pregnancy than did younger mothers, and intake of calcium had a protective effect only in the latter half of pregnancy, an effect that became stronger as pregnancy progressed. These findings provide further evidence to our study that lead is mobilized from bone during the latter half of pregnancy and that calcium intake may reduce BPb levels.[5]

BPb concentration in present study (table 4) was found higher in 7 (100%) pregnant women who had gravida 4. The concentration of lead was found more than 10 µg/dl in 28 (77.78%) women having multiple gravida while the number is only 3 (14.28%) in primigravida women. Concentration of BPb was more than 10µg/dl in those 16 women (84.21%) who had history of one or

two abortions. Therefore it may be concluded that BPb concentration had some role in spontaneous abortion in pregnant women.

Figueroa et al studied 207 pregnant Mexico City residents during pregnancy, originally recruited for two cohorts between 1997 and 2004. The mean number of miscarriages was 0.42 (range 0 to 4); mean Pb concentrations were 62.4 and 0.14µg/L in whole blood and plasma respectively. Mean plasma/blood Pb ratio was 0.22%. They estimated that a 0.1% increment in the plasma/blood Pb ratio lead was associated to a 12% greater incidence of spontaneous abortion. Women in the upper tertile of the plasma/blood Pb ratio had twice the incidence rate of those in the lower tertile. Women with a large plasma/whole blood Pb ratio may be at higher risk of miscarriage, which could be due to a greater availability of placental barrier-crossing Pb.[32]

Conclusion

In polluted environment pregnant woman is a potential source of lead intoxication for babies during prenatal development and her social background can influence the concentration of lead in prenatal development of neonates. The positive correlation between lead levels in maternal and cord blood found in the study shows the transport of lead from mother to fetus during pregnancy therefore, a careful analysis of a mother's environment is needed to reduce the risk of prenatal exposure to lead.

Further detailed study on this issue will be necessary in the studied area to verify these hypotheses. Assessing the influence of lead and probability of suffering from abortion/miscarriage will be very important to identify groups particularly susceptible to the effects of lead exposure during pregnancy. Therefore, attempts should be done to lessen exposure of lead as environmentally toxic pollutant.

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