

Occupational lead exposure and its effect on human liver functions

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Abstract

Introduction: A Comparative study of persons working in lead based industries and non-lead based industries were undertaken to evaluate the effect of lead on liver function tests. This study was done to evaluate the ill effects of lead on liver functions as there were very few studies available to show the ill effects of lead on human liver.

Materials and Methods: Subjects were classified as:

Group-A: Controls- individuals who were working in non-lead based industries.

Group B: individuals who were working in lead based industries.

Results: The study showed that there was statistical significance between the group A and group B in BLL (p<0.001), Hb (p<0.001), ALAD (p<0.001) and ZPP (p<0.001). There was also statistically significant difference in two groups in Total Bilirubin (p<0.001), Direct Bilirubin (p<0.001), Indirect Bilirubin (p<0.001) and Total Protein (p<0.001). There was no significant difference in liver enzymes between the two groups.

Conclusions: As lead being a toxic element affecting multiple organs, including liver as emphasized in this study shows the importance of regulation in lead based industries in a country like India.

Keywords: BLL, Lead, LFT, Lead based occupational workers, Non-lead based occupational workers, ZPP.

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Introduction

India being a developing country needs to emphasize the importance in tackling environmental toxicity as it has joined a league of big nations in industrial revolution. Of the present environmental toxins, Lead is now considered as number one environmental pollutant.^{1,2} Once enters inside the human body it has no known biological functions and causes adverse health effects.³

The major source of lead for adults is from occupation where lead and lead components are used- resulting in high prevalence of lead toxicity in the population exposed to such activity.

Different occupations where workers will experience the highest and most prolonged occupational exposure to lead were individuals working in paint industry, secondary smelting, Lead acid battery manufacturing units, battery recycle and repair units, automobile repair, printing, welding and computer waste management.^{4,5,6}

Exposure due to occupational usage of lead remains a big problem in developing countries like India and this is very much unregulated with little monitoring of the poisoning being done.⁷

Previous research provides a definite proof that exposure to lead causes significant adverse effects to multiple organ systems like Nervous, Haematological, Renal and Reproductive systems but very few human studies have been conducted to know the effect of lead on liver functions.⁸ There is no available data to know the ill-effects of lead on liver functions in Indian scenario. Since liver is the major organs of storage, biotransformation and detoxification of lead we wanted to evaluate the toxic effects of this metal on liver functions.

Materials and Methods

The study was carried out at the National Referral Centre for Lead Poisoning in India at St. John's Medical College Bangalore. Experiments were carried out by collecting blood samples from lead based industrial workers and the results were compared with controls.

Subjects studied were classified as:

Group-A: Controls- Comprised of individuals who were working in non-lead based industries.

Group B: Comprised of individuals who were working in lead based industries.

Methods: The subjects were evaluated for

1. Estimation of blood lead by anodic stripping voltammetry using the esa-3010B lead analyser.^{9,10}
 2. Estimation of Hemoglobin in the whole blood by Drabkin's Method (1973).^{11,12}
 3. Estimation of erythrocyte δ aminolevulinic acid dehydratase (δ ALAD) activity by the method of Berlin and Schaller.¹³
 4. Estimation of Zinc Protoporphyrin in Erythrocytes by using AVIV Hematofluorometer.¹⁴
- Other parameters were evaluated using fully automated analyser-ERBA-Excel 300.

Results

Table 1: Comparison of Biomarkers of lead exposures in categories

Biomarkers of lead exposures	Controls	Group A	P value
BLL(μ g/dl)	5.29 \pm 3.05 (0.7-13.3)	43.67 \pm 34.87 (7.3-189.6)	<0.001
Hb(%)	14.15 \pm 1.37 (12.12-17.95)	12.31 \pm 1.78 (6.6-16.87)	<0.001
ALAD (μ moles/ min/L)	51.50 \pm 7.11 (32.8-64.4)	36.53 \pm 11.38 (13.56-61.0)	<0.001
ZPP (μ g/dl)	23.22 \pm 6.71 (10.0-38.0)	62.24 \pm 42.54 (12.0-295.0)	<0.001

Results are presented as Mean \pm SD (Min-max)

Table 2: Levels of biomarkers of lead exposures in lead based industrial workers according to gender

Biomarkers of lead exposure	Gender	Controls	Group A	P value
BLL(μ g/dl)	Male	5.41 \pm 3.18	44.83 \pm 34.99	<0.001
	Female	4.91 \pm 2.62	30.78 \pm 31.60	<0.001
	P value	0.446	0.112	
Hb(%)	Male	14.58 \pm 1.19	12.37 \pm 1.81	<0.001
	Female	12.80 \pm 0.94	11.64 \pm 1.26	<0.001
	P value	<0.001**	0.107	
ALAD (μ moles/ min/L)	Male	52.06 \pm 7.02	36.17 \pm 11.48	<0.001
	Female	49.75 \pm 7.28	40.53 \pm 9.59	<0.001
	P value	0.135	0.130	
ZPP (μ g/dl)	Male	23.59 \pm 6.69	62.87 \pm 43.19	<0.001
	Female	22.07 \pm 6.75	55.18 \pm 34.79	<0.001
	P value	0.299	0.476	

Table 3: Comparison of Liver function tests

Liver function tests	Controls	Group A	P value
AST (IU/L)	24.26 \pm 9.67 (10.42-78.02)	24.47 \pm 10.65 (11.1-141.0)	0.860
ALT (IU/L)	23.21 \pm 10.39 (6.94-64.0)	21.55 \pm 11.23 (5.72-125.0)	0.192
ALP (K.A.Units)	9.51 \pm 2.56 (4.6-24.4)	9.91 \pm 3.01 (4.6-27.01)	0.2172
GGT (U/L)	19.75 \pm 8.66 (4.0-47.0)	20.90 \pm 8.38 (3.9-52.8)	0.2593
Total Bilirubin (mg/dl)	0.59 \pm 0.20 (0.3-1.35)	0.97 \pm 0.40 (0.4-3.11)	<0.001
Direct Bilirubin	0.21 \pm 0.10	0.41 \pm 0.23	<0.001

(mg/dl)	(0.1-0.67)	(0.1-1.36)	
Indirect Bilirubin (mg/dl)	0.37±0.13 (0.1-0.85)	0.56±0.23 (0.16-1.75)	<0.001
Total protein (g/dl)	7.44±0.52 (6.23-8.78)	7.08±0.64 (5.6-9.0)	<0.001
Albumin (g/dl)	4.13±0.40 (3.1-5.0)	3.99±0.32 (3.01-4.9)	0.0018
Globulin (g/dl)	3.31±0.42 (2.2-4.5)	3.08±0.47 (1.7-4.6)	<0.001
A/G ratio	1.26±0.25 (0.18-1.95)	1.31±0.24 (0.9-2.4)	0.0889

This study shows that there was statistical difference between the two groups in BLL ($p<0.001$), Hb ($p<0.001$), ALAD ($p<0.001$) and ZPP ($p<0.001$). This was similar to some of the earlier studies done in Indian scenario.¹⁵ According to Centre for Disease control and prevention increase in BLL as a single parameter would be evident of lead poisoning.¹⁶ In our study the BLL levels were significantly increased in the Lead based industrial workers.

There was no statistical difference in gender which was done for BLL, Hb ALAD and ZPP. There was statistical difference in Total Bilirubin ($p<0.001$), Direct bilirubin ($p<0.001$) and Indirect bilirubin ($p<0.001$). There was significant difference in Total protein ($p<0.001$) and globulin ($p<0.001$) between the groups which was similar to one of the earlier done animal studies (17). One of the animal studies had suggested an increase in the liver enzyme parameters in lead exposed rats (18), but in our study there was no statistical difference in the two groups for AST, ALT, ALP and GGT.

Thus this study signifies toxic effects of Lead on Liver and also signifies the importance of regulatory mechanism required for prevention of Lead poisoning.

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Abbreviations:

ALAD-Amino levulinic acid dehydratase

ALP-Alkaline Phosphatase

ALT-Alanine Transaminase

AST-Aspartate Transaminase

BLL-Blood Lead Level

GGT-Gamma Glutamyl Transferase

Hb-Hemoglobin

ZPP-Zinc Protoporphyrin