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Oxidative Stress Status in Lead Exposed Workers

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Abstract

Objective. Lead is a widespread heavy metal that can persist in water, plants and soil in environment naturally. When it is used in some industries, it turns to destructive and toxic form. Human exposure can be associated with the use of lead containing ceramic dishware, food cans and paints besides the exposure in the workplace. One of the most possible mechanisms that cause Pb-induced toxicity is oxidative stress. We aimed to evaluate TAS (total antioxidant status), TOS (total oxidant status) and OSI (oxidative stres index) levels in patients with lead exposure.

Methods. 30 workers with chronic lead exposure who admitted to Ankara Occupational Diseases Hospital and 35 healthy controls were included in the study. The workers were from 50% battery (n=15), 30% welding (n=9) and 20% recycling (n=6) factories. TAS, TOS levels were measured in blood samples and OSI was calculated according to formula (TOS/TAS).

Results. TOS levels were significantly higher in patient group (p=0.001). There was no significant difference in terms of TAS levels. Calculated OSI levels were significantly higher in patient group (p<0.001).

Conclusion. Our data confirms that lead exposure is associated with incerased oxidative stress. TAS, TOS and OSI levels can be used to evaluate antioxidant-oxidant balance in lead exposure.

Keywords. Lead Exposure, Total Antioxidant Status, Total Oxidant Status, Oxidative Stress

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INTRODUCTION

Humans' exposure to harmful metals such as lead has increased significantly with the development of industry and rapidly growth technology [1]. Except air, water and soil welded lead exposure, occupational exposure can be seen in people working in industries like automobile batteries, paints, cosmetics, medicines, ceramics [1-3]. Lead turns destructive and toxic form when it is used industries [4]. Lead exposure is related to a range of physiologic, biochemical and behavioral dysfunctions [2]. Harmful effect of lead exposure depends on received dose, way of absorption, exposure period, age, gender and the presence of other xenobiotics [1].

Lead exposure has effects on nervous, renal, hematopoeitic and cardiovascular systems [1, 3]. Molecular, cellular and intracellular mechanisms are thought to explain lead toxicity [5]. One of the major phenomenas of lead induced toxicity has been reported as oxidative stress [2, 5]. Oxidative stress is a state of imbalance in the reactive oxygen species (ROS) production and degradation [6]. Lead exposure causes generation of ROS that affects cell membranes with raising lipid peroxidation and permeability while simultaneosuly inactivating the anxioxidant enzymes to impair antioxidant defence systems of cells [1, 5].

Serum levels of antioxidants can be measured individually but it is usually time consuming, expensive. Also, the seperate measurements of the antioxidants may not reflect the whole status. Therefore several methods developed to evaluate the oxidant and antioxidant status by allowing to measure serum levels of total oxidant status(TOS) and total antioxidant status (TAS) [7, 8].

To our best knowledge, oxidative status of lead exposured patients has not been investigated using serum total antioxidant status (TAS) and serum total oxidant status (TOS) measurement, oxidative stres index (OSI) calculation. In the present study we aimed to evaluate and present total antioxidant status, total oxidant status and oxidative stres index(OSI) in patients with lead exposure.

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MATERIALS AND METHODS

Exposure group patients were consisted of with a total number of 30 patients from 50% battery (n=15), 30% welding (n=9) and 20% recycling (n=6) factories, who admitted to Ankara Occupational Diseases Hospital for annual health examination. 35 healthy adults without Pb exposure and with normal physical examination and laboratory results within normal ranges were included in the study as the control group.

Venous blood samples were collected in vacutainer tubes and centrifuged at 1300 g for 10 minutes. Sera were seperated and stored at -20°C until analysis.

Serum total antioxidant status (TAS) levels were measured by fully automated third generation colorimetric assay (Rel Assay Diagnostics,Turkey) in Beckman Coulter AU680 chemistry analyzer (Tokyo, Japan). The results were expressed as mmol Trolox equivalent/L.

Serum total oxidant status (TOS) levels were measured by fully automated third generation colorimetric assay (Rel Assay Diagnostics,Turkey) in Beckman Coulter AU680 chemistry analyzer (Tokyo, Japan). The results were expressed as μmol H_2O_2 equivalent/L.

The ratio of TOS and TAS levels was accepted as oxidative stress index(*). The index was calculated according to the formula: OSI (arbitrary unit) = TOS (μmol H_2O_2 equivalent/L) / TAS (mmol Trolox equivalent/L).

Whole blood lead determination was performed by Ankara Occupational Diseases Hospital toxicology laboratory using .Varian AA 240Z atomic absorption spectrophotometry.

The findings of this study were analyzed with "The Statistical Package for Social Sciences for Windows" (SPSS v18) software. The conformity of continuous variables to normal distribution was tested with Kolmogorov-Smirnov test. The descriptive statistics of continuous variables were expressed as median (min-max). The presence of a statistically significant difference between the groups in terms of continuous variables was examined with Mann Whitney U test for non-parametric variables. The presence of a correlation between the

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groups was searched with Spearman's rho tests. P<0.05 was considered the threshold of statistical significance for all tests.

RESULTS

30 patients with lead exposure were included in this study. Control group with a number of 35 were enrolled. Lead exposure group were 24-64 years of age (median, 39,0) and control group were 18-69 years of age (median, 38,0).

In lead exposure group, median blood lead level was 45,0 µg/dL with a minimum value of 21 and a maximum value of 72 µg/dL. In lead exposure group, median of serum TOS and TAS levels were 3,77 (1,85-11,64) µmol H_2O_2 equivalent/L and 1,45 (1,19-1,88) mmol Trolox equivalent/L, respectively. In the control group median of serum TOS and TAS levels were found to be 2,88 (1,17-6,87) µmol H_2O_2 equivalent/L and 1,53 (1,22-2,12) mmol Trolox equivalent/L respectively. Median of calculated OSI levels were 2,39 (1,14-8,62) arbitrary unit in patient group and 1,86 (0,8-4,31) arbitrary unit in control group (Table).

Table: Demographic, oxidative and antioxidative parametres in lead exposed patients and controls

	Patient group (n=30)	**Control group (n=35)**
Age (years)	**39 (24-64)***	**38 (18-69)***
TOS levels (µmol H_2O_2 equivalent/L)	**3,77 (1,85-11,64)***	**2,88 (1,17-6,87)***
TAS levels (mmol Trolox equivalent/L)	**1,45 (1,19-1,88)***	**1,53 (1,22-2,12)***
OSI (arbitrary unit)	**2,39 (1,14-8,62)***	**1,86 (0,8-4,31)***

*:Values are expressed as median (min-max)

Serum TOS levels were significantly higher in patient group than in control group($p=0.001$). There was no significant difference in terms of TAS levels ($p>0.05$) between the groups. Calculated OSI levels were significantly higher in patient group ($p<0.001$).

DISCUSSION

Lead is one of the most dangerous and widespread heavy metals existed in environment. Lead provides no useful function in organisms [9]. There is no level of lead has been found that can be necessary to the body or no safe level has been determined about lead exposure [3].Using low lead paints, unleaded petrol and banning the use of lead in food containers has fallen down the lead exposure of general population[2]. However, occupational lead exposure affects workers in industries like battery, welding and recycling. Lead primarily affects nervous, hematopoietic, hepatic and renal systems. Several mechanisms has been described to explain toxicological effects of lead like ionic mechanisms, oxidative stress and apoptosis [3]. Oxidative stress has been found to be more declared and more severe than others. Lead induced toxicty causes generation of ROS and impairs antioxidant defense system, the damage occurs in molecules like DNA, enzymes, protein and lipids.

In the present study, we observed that patients with lead exposure had oxidative/antioxidative balance towards oxidative status. We used OSI in order to evaluate the status of subjects objectively and oxidative stress was present in the patients compared with control group. It is known that oxidative stress is one of the mechanisms in lead induced toxicity and several studies have been done in which δ-aminolevunic acid, glutathione and malondialdehyde levels were examined in order to show oxidative stress status [1, 10, 11].

In conclusion, TAS and TOS levels can be used for evaluating oxidative status in lead exposure. As the measurement of the parameters is rapid,easy, inexpensive and can be applied to the automated devices.

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