

Original Research Article

Association of hearing loss and lead exposure in a North Indian tertiary hospital: a pilot study

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ABSTRACT

Background: Lead poisoning is one of the most common metal poisonings. Lead is present in many man-made structures, work environments and various products. It has been consistently shown that low as well as high exposure levels to heavy metals have an adverse effect on human health, leading to conditions such as cardiovascular and pulmonary dysfunctions.

Methods: A total of 25 patients (50 ears) presented with hearing loss were included in the study on the basis of inclusion and exclusion criterion. All the patients were subjected to pure tone audiometry and blood lead levels followed by data analysis. Statistical analysis was used and data was analysed using Statistical package for social sciences (SPSS) 21.0 software. Chi-square test and ANOVA were used to compare the data. P value less than 0.05 was considered as significant.

Results: Age group of patients included in study was 5-50 years with female predominance. Blood lead levels were independent of sex and age of patient, however statistical association was noted with pure tone audiometry (hearing loss).

Conclusions: As positive correlation was observed between lead levels and hearing loss, we emphasize on the fact that further studies on a larger sample size including a control arm should be planned.

Keywords: Lead toxicity, Hearing loss, Serum lead levels

INTRODUCTION

Lead poisoning is one of the most common metal poisonings.¹ Lead is present in many man-made structures, work environments and various products. It has been consistently shown that low as well as high exposure levels to heavy metals have an adverse effect on human health, leading to conditions such as cardiovascular and pulmonary dysfunctions.^{2,3} In addition, some studies have shown an association between exposure to heavy metals and hearing disorders in animals.^{4,5}

Wu et al showed that lead toxicity had an adverse impact on the peripheral fibers of the auditory nerve.⁶ In addition, abnormalities in auditory brainstem response (ABR) latencies induced by lead exposure have been shown to occur in rhesus monkeys.⁷ A recent report has linked Beethoven's progressive hearing loss to axonal degeneration due to a continuous exposure to lead.⁸ Occupational lead exposure is often originated in work environments such as steel plants, glass factories.¹²⁻¹⁴ And other industries using lead-based products or processes.^{9,10,11,15,16} Non-occupational lead exposure is often caused by the use of gasoline with lead additives,

incineration of lead-containing waste, lead-based paints used in homes, ceramic glazes containing lead, electronic waste, other industrial lead-based product factories, lead-containing water networks and contaminated food chains.¹⁶⁻²⁹ Other symptoms of lead poisoning are anemia, abnormal behavior, irritability, and difficulty in concentration. Abdominal colic, paroxysms of pain, encephalopathy, delirium, coma, seizures and headache. In today's world patient of younger age group presenting with hearing loss with no other identifiable cause but there was exposure to lead either due to occupational hazard or environmental exposure. Thus, the study aims to establish a relationship between hearing loss and lead exposure.

METHODS

Prospective study was conducted in the Department of Otorhinolaryngology and Department of Personalized and Molecular Medicine to correlate Association of Hearing loss and lead exposure in a North Indian tertiary hospital, after obtaining clearance from the institutional ethical committee. Study was conducted from June 2019 to August 2019. Written informed consent was taken from all the enrolled subjects.

Aim

The aim of the study was to establish a relationship between hearing loss and lead exposure.

Objective

The main objective of the study was to correlate pure tone audiometry findings with serum lead levels in patients with hearing loss.

Inclusion criteria

The study subjects were selected if they fulfilled following mentioned inclusion criteria: patients aged 5-50 years, having history of occupational or non-occupational lead exposure, patients with sensorineural hearing loss (SNHL) on a screening audiogram (PTA).

Exclusion criteria

The study subjects were excluded based on the following criteria: patients who gave history of exposure to loud sound, history of intake of ototoxic drugs (aminoglycosides, quinines), diabetic patients, history of middle ear pathology, non-cooperative and unconscious patients, patients with end-stage kidney/liver or cardiac diseases and patients with history of stroke (Cerebrovascular accident) or hypertension or known neurological disorder.

Methodology

The present prospective study was conducted on 25 patients (50 ears) in the Department of

Otorhinolaryngology, and Department of Personalized and Molecular Medicine to correlate Association of Hearing loss and lead toxicity in a North Indian tertiary hospital, after obtaining clearance from the institutional ethical committee. The study was conducted from June 2019 to August 2019.

Sampling technique

Randomization was done by computer software. Patients were included according to inclusion and exclusion criteria. Complete ENT examination was done including: all the patients with sensorineural hearing loss on PTA, their blood samples were collected and were evaluated for lead levels. Blood lead level estimation was done. A Lead care II (Meridian Bioscience, Cincinnati, OH, USA) analyzer using an electrochemical technique called anodic stripping voltammetry 15 was used to determine the amount of lead in the blood samples. The Lead care II system relies on electrochemistry and has a unique sensor to detect lead (detectable range 3.2-60 µg/dl) in whole blood. When whole blood is mixed with the treatment reagent, the red blood cells are lysed, and the lead is made available for detection. When a test is run, the analyzer applies a potential that causes the lead to collect on the Lead care II sensor. After three minutes, the analyzer measures the amount of lead collected on the sensor and display the result in µg/dl.³⁰

Categorization of serum lead levels were done³⁰

<3.3 µg/dl	-	Safe
3.3-10 µg/dl	-	Moderate exposure
>10 µg/dl	-	Heavy exposure

Data analysis

Data was analyzed using Statistical package for social sciences (SPSS) 21.0 software. Chi-square test and ANOVA were used to compare the data. P value less than 0.05 was considered as significant.

RESULTS

Patients included in the study were in the age group of 5 years to 50 years and the mean age of patients in study was 40.08±13.84 years (Figure 1). Out of 25 patients, majority of the patients were female (17/25) accounting for (68%) (Figure 2). Patients were categorized according to the lead levels as serum lead levels of: <3.3 µg/dl, between 3.3-10 µg/dl and >10 µg/dl respectively.

Patients who had lead levels <3.3 µg/dl were 8, lead levels between 3.3-10 µg/dl were 15 and lead levels >10 µg/dl were 2 (Figure 3).

Table 1: Association between Lead Levels and Clinicodemographic profile of patients.

Variable	Lead Levels			Statistical significance
	<3.3 g/dl (n=8)	3.3-10 g/dl (n=15)	>10 g/dl (n=2)	
Mean Age±SD	46.13±7.74	36.73±15.94	41.00±12.73	F=1.228; p=0.312
Sex				
Male	6 (75.0%)	9 (60.0%)	2 (100%)	X ² =1.563; p=0.458
Female	2 (25.0%)	6 (40.0%)	0	
	(n=16)	(n=30)	(n=4)	
Mean AC±SD	42.94±6.88	38.33±6.61	47.50±8.66	F=4.607; p=0.015
Mean BC±SD	40.00±4.02	36.13±7.22	45.25±3.11	F=4.991 p=0.011

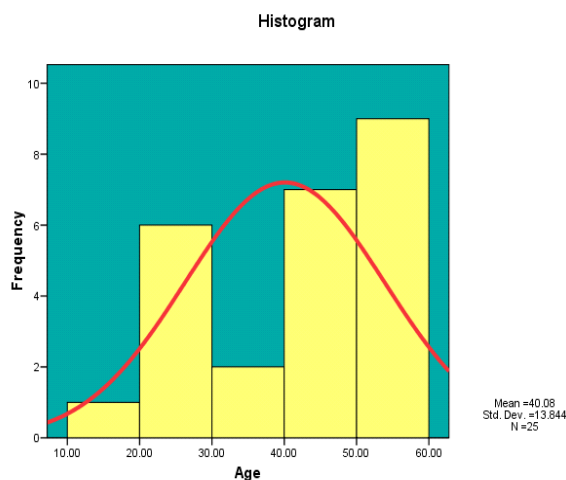


Figure 1: Age profile.

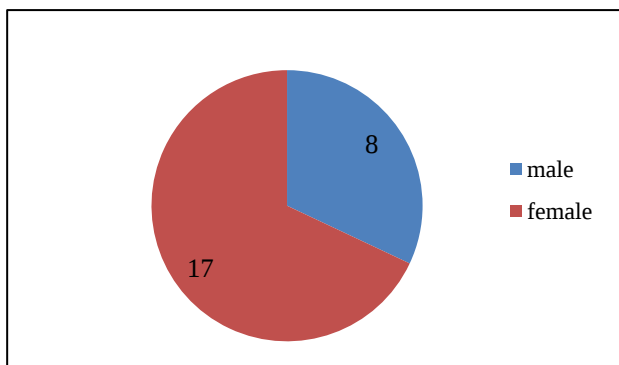


Figure 2: Gender profile.

Mean air conduction for patients with lead levels <3.3 µg/dl, 3.3-10 µg/dl and >10 µg/dl were 42.94±6.88, 38.33±6.61 and 47.50±8.66 respectively which was found to be statistically significant (p<0.05) (table 1). Mean bone conduction for patients with lead levels <3.3 µg/dl, 3.3-10 µg/dl and >10 µg/dl were 40.00±4.02, 36.13±7.22 and 45.25±3.11 respectively which was also found to be statistically significant (Table 1). Bone conduction was found to be more statistically significant than air conduction.

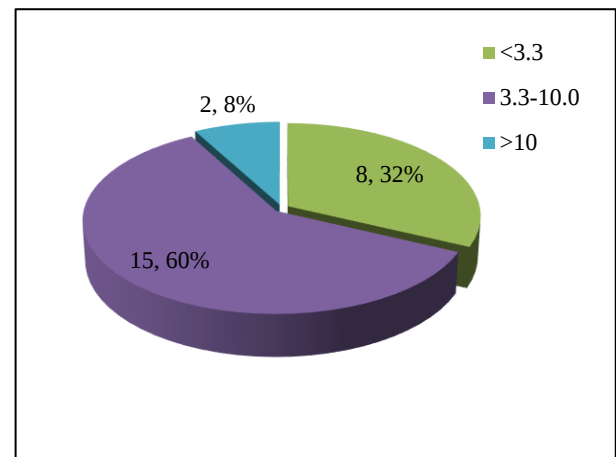


Figure 3: Serum lead levels.

DISCUSSION

The proportion of young patients with unexplained hearing loss having serum lead levels above >3.5 µg/dl was 68%. Shargorodsky et al reported, in a study, that high-frequency hearing impairment was seen in a group with a blood lead level above 2 µg/dl as compared to a reference group.³¹ In present study, air and bone conduction frequencies of patients with high lead exposure were found to be of higher order, and the association was statistically significant too for air and bone conduction frequency. Thus, indicating a possible relationship between lead exposure and hearing loss.

These findings are in agreement with the observations of Ghiasvand et al who in a population of occupational lead exposure found a significant association between level of lead exposure and pure tone audiometry results.³² Kang et al in a recent study based on Korean National Health and Nutritional Examination Survey results also found that even exposure to low-level lead is a risk factor for high-frequency hearing loss.³³

The findings of present study thus show that lead exposure could be a possible reason for hearing loss in young patients having no other plausible cause.

CONCLUSION

60 percent of the patients (31-50 years) who presented with high frequency of hearing loss had serum levels above $>3.3 \mu\text{dl}$. No significant association of level of lead exposure could be seen with age or gender of the patients. The pure tone audiometry for air conduction and bone conduction frequencies were of higher order among patients with higher levels of lead exposure and the association was statistically significant for air and bone conduction frequency. The findings of our study suggest that hearing loss in individuals at risk of environmental or occupational exposure could be owing to their exposure to lead above safety levels. On the basis of findings of present study, it could be recommended that individuals at risk of environmental or occupational lead exposure should be regularly monitored for hearing impairment and efforts should be made to reduce their risk exposure.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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