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Brief Report

Gastrointestinal Manifestations of Lead Poisoning: A Brief Report

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Abstract

Gastrointestinal (GI) manifestations of lead poisoning include abdominal pain, constipation, and diarrhea. Depending on the severity of a symptom, surgical consultation is required. The present study aimed to make a comparison between the mean blood lead levels of patients hospitalized for lead toxicity and the various Gl symptoms. A retrospective cross-sectional study was performed in 2020 at Khorshid Hospital, the main regional referral center for poisoned patients (Isfahan, Iran). A total of 82 patients aged ≥18 years who were hospitalized for lead poisoning during 2017-2018 were included in the study. Patients' information was extracted from hospital medical records, including demographic information, clinical manifestations, blood lead levels, and treatment outcome. The mean age of the patients was 48.18±11.9 years, 91.5% were men, and 62.2% suffered from multiple GI symptoms, with abdominal pain being predominant (31.7%). Blood lead levels in patients with multiple GI symptoms were higher than those with only one symptom (P=0.01). Surgical consultation was required in 14.6% of the patients. Multiple GI symptoms were the main predictive factor for blood lead levels above 70 mg/dL (P=0.03, Odds ratio=3.06, 95% CI=1.09-8.61). Given the prevalence of abdominal pain and its association with elevated blood lead levels, differential diagnosis of abdominal pain should include lead toxicity.

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Keywords ● Lead ● Poisoning ● Blood lead level ● Gastrointestinal symptoms ● Abdominal pain

What's Known

- In developing countries, lead toxicity is a major environmental disease with severe effects on the human body.

What's New

- Blood lead levels in patients with multiple gastrointestinal symptoms were higher than in patients with only one symptom.
- Multiple gastrointestinal symptoms are the main predictive factor for blood lead levels above 70 mg/dL.

Introduction

Lead is a heavy metal used in many industries to manufacture a wide variety of products. Lead poisoning due to exposure to lead dust during the mining process and the use of lead-based products has become a major health concern in many parts of the world. The most common source of lead poisoning is lead dust in the air, soil, water, consumer products, and certain foods. In recent years, studies have reported an increased prevalence of lead poisoning among users of lead-contaminated opium and amphetamine.[1-5] Drinking water may also be regarded as a potential source of lead exposure in certain areas with a plumbosolvent water supply.[6] However, there are limited studies on water quality factors that affect lead bioavailability and toxicity in water.

In developing countries, lead toxicity is a major environmental disease with severe effects on the human body. Lead poisoning

can be acute (intense exposure for a short time) or chronic (prolonged low-level exposure), with the latter being more common. Both acute and chronic lead exposure cause gastrointestinal (GI) problems (e.g., abdominal pain, constipation, and diarrhea) and are associated with increased neurological and psychiatric morbidity.[5, 6] In severe cases, it may even cause anemia, seizures, coma, or death.[7] To date, no specific safe threshold for blood lead levels is defined. However, a reference level of 5 µg/dL is considered acceptable in children, although lower levels may also be harmful and impair their growth.[2]

Several studies have investigated the association between blood lead levels and abdominal pain as well as its intensity.[8-11] Given the severity of GI problems caused by lead poisoning, which sometimes even requires surgery, the present cross-sectional study aimed to compare the mean blood lead levels of patients hospitalized for lead toxicity and the various GI symptoms.

Materials and Methods

A retrospective cross-sectional study of patients suffering from lead poisoning was performed in 2020 at Khorshid Hospital, the main regional referral center for poisoned patients (Isfahan, Iran). The study was performed in accordance with the 1964 Helsinki Declaration and its later amendments. The study was approved by the Ethics Committee of Isfahan University of Medical Sciences, Isfahan, Iran (IR.MUI.MED.REC.1398.193). Written informed consent was obtained from the patients, their parents, or legally authorized representatives.

Using the census sampling method, all patients aged ≥18 years hospitalized for lead poisoning in 2017-2018 were included in the study. The patients were divided into three age groups, namely 18-29 years, 30-60 years, and >60 years. Based on the International Classification of Diseases, 10th revision (ICD-10) code, patients' information was extracted from hospital medical records. The information included patient demographics (age, sex), GI symptoms (abdominal pain, nausea, constipation, etc.), neurological symptoms (level of consciousness, sensory and motor disturbances), length of hospital stay, treatment modalities (medications, consultations, diagnostic procedures), and treatment outcome (recovery with/without complications, death). Uniform handling of the collected data was ensured by reaching a consensus during team meetings.

Statistical Analysis

The data were analyzed using SPSS software, version 24.0 (SPSS Inc., Chicago, IL, USA) and expressed as mean±SD, median, and frequency (percentage). The Chi square test and Fisher's exact test were used to compare the frequency distribution of variables within the groups. Data normality was assessed using the Kolmogorov-Smirnov test. Using the analysis of variance (ANOVA) and Tukey's *post hoc* test, the difference between the mean of multiple groups was examined. Moreover, backward stepwise binary logistic regression analysis was used to calculate the odds ratio (OR) as the estimated predictive factor for blood lead levels above 70 mg/dL. Based on the blood lead levels, patients were further divided into two groups (below and above 70 mg/dL). $P<0.05$ was considered statistically significant.

Results

A total of 82 patients hospitalized for lead poisoning were included in the study. The mean age of the patients was 48.18±11.9 years, 91.5% were men, and 74.4% were self-employed. Most of the patients suffered from multiple GI symptoms (62.2%) with abdominal pain (31.71%) as the main manifestation. The neurological disorder was identified in 25.6% of patients, of which 12.2% had sensory disturbance symptoms. Surgical intervention for GI manifestations was considered for 14.6% of patients, however, diagnostic tests showed surgery was not required. Following appropriate evaluations, any cardiovascular and prior surgical causes of abdominal pain were ruled out.

Tables 1 and 2 present the frequency distribution of clinical manifestations and blood lead levels in terms of sex and age of the patients, respectively. There was a significant difference in the frequency distribution of neurological symptoms between the age groups. Single neurological manifestation was more common in the age group 30-60 years, while multiple neurological symptoms were observed in the age group 18-29 years (66.7%) and older than 60 years (33.3%) (P=0.002). The average blood lead level in patients with multiple GI symptoms was significantly higher than in those with a single symptom (82.85±25.52 vs. 68.68±30.54, P=0.03). Multiple GI symptoms were the main predictive factor for blood lead levels above 70 mg/dL (P=0.03) (table 3). However, there was no significant difference in the mean blood lead level between the male and female patients (P=0.23, data not shown).

Table 1: Frequency distribution of variables associated with lead poisoning for both male and female patients

Variables		Patients			P value
		Total	Male (n=75)	Female (n=7)	
Gastrointestinal symptoms	Nausea/vomiting	4	4 (100%)	0 (0)	0.98
	Abdominal pain	26	23 (88.5%)	3 (11.5%)	
	Constipation	1	1 (100%)	0 (0)	
	Multiple symptoms	51	47 (92.2%)	4 (7.8%)	
Neurological symptoms	No symptoms	61	58 (95.1%)	3 (4.9%)	0.13
	Decreased consciousness	3	2 (66.7%)	1 (33.3%)	
	Sensory disorder	10	9 (90%)	1 (10%)	
	Headache	2	2 (100%)	0 (0)	
	Limb tremor	3	2 (66.7%)	1 (33.3%)	
	Multiple symptoms	3	2 (66.7%)	1 (33.3%)	
Treatment outcome	Recovery without complications	78	71 (91%)	7 (9)	0.80
	Recovery with complications/death	4	4 (100%)	0 (0)	
Surgical recommendations and procedures	No advice	70	64 (91.4%)	6 (8.6%)	0.82
	Abdominal radiograph in the upright or supine position	4	4 (100%)	0 (0)	
	Chest radiograph	1	1 (100%)	0 (0)	
	CT scan of abdomen and pelvis	2	2 (100%)	0 (0)	
	Other diagnostic tests	5	4 (80%)	1 (20%)	
Surgical actions	Not required	80	74 (91.7%)	6 (8.3%)	0.16
	Gastrointestinal obstruction	2	1 (50%)	1 (50%)	

Results are expressed as numbers and percentages. Chi squared test or Fisher's exact test was used to compare the frequency distribution in the groups. Statistical significance at P<0.05.

Table 2: Frequency distribution of variables associated with lead poisoning for different age groups

Variables		Age (years)			P value
		18-29 (n=7)	30-60 (n=64)	>60 (n=11)	
Gastrointestinal symptoms	Nausea/vomiting	2 (50%)	2 (50%)	0 (0)	0.98
	Abdominal pain	1 (3.9%)	22 (84.6%)	3 (11.5%)	
	Constipation	0 (0)	1 (100%)	0 (0)	
	Multiple symptoms	4 (9.8%)	39 (74.5%)	8 (15.7%)	
Neurological symptoms	No symptoms	4 (6.6%)	52 (81.3%)	5 (8.2%)	0.002
	Decreased consciousness	0 (0)	2 (66.7%)	1 (33.3%)	
	Sensory disorder	0 (0)	8 (80%)	2 (20%)	
	Headache	1 (50%)	0 (0)	1 (50%)	
	Limb tremor	0 (0)	2 (66.7%)	1 (33.3%)	
	Multiple symptoms	2 (66.7%)	0 (0)	1 (33.3%)	
Treatment outcome	Recovery without complications	6 (7.7%)	62 (79.5%)	10 (12.8%)	0.13
	Recovery with complication	1 (50%)	1 (50%)	0 (0)	
	Death	0 (0)	1 (50%)	1 (50%)	
Surgical recommendations	No advice	6 (8.6%)	55 (78.6%)	9 (12.8%)	0.32
	Abdominal radiograph in the upright or supine position	0 (0)	4 (100%)	0 (0)	
	Chest radiograph	0 (0)	1 (100%)	0 (0)	
	CT scan of abdomen and pelvis	1 (50%)	1 (50%)	0 (0)	
	Other diagnostic measures	0 (0)	3 (60%)	2 (40%)	
Surgical actions	Not required	7 (9.7%)	63 (77.8%)	10 (12.5%)	0.74
	Gastrointestinal obstruction	0 (0)	1 (50%)	1 (50%)	
Blood lead levels	Single GI symptom	27.25±17.05*	71.08±5.91	66.05±17.67	0.02
	Multiple GI symptoms	78.60±12.24	85.19±4.14	73.8±11.05	0.32
Blood lead levels	Without neurological symptoms	78.25±15.80	80±4.00	65.99±18.65	0.27
	With neurological symptoms	44.83±20.15	77.01±7.69	75.14±9.58	

Results are expressed as numbers and percentages or mean±SD as appropriate. Chi squared test and Fisher's exact test were used to compare the frequency distribution in the groups. ANOVA was used for statistical analysis. *Tukey's test was used for *post hoc* analysis. Statistical significance at P<0.05.

Table 3: Predictive factors for blood lead level above 70 mg/dL in patients with lead poisoning

Variables	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age	1.01 (0.96-1.05)	0.73	1.91 (0.97-1.05)	0.51
Multiple gastrointestinal symptoms	3.79 (1.36-10.51)	0.01	3.06 (1.09-8.61)	0.03
Sex (female)	3.64 (0.74-17.83)	0.11	2.16 (0.44-10.62)	0.34
Occupation (self-employment)	0.62 (0.38-1.02)	0.06	0.71 (0.43-1.15)	0.17
Multiple neurological symptoms	0.58 (0.20-1.67)	0.31	0.83 (0.27-2.56)	0.75

OR: Odds ratio; CI: Confidence interval; Backward stepwise binary logistic regression was used for analysis. Statistical significance at P<0.05

The length of hospital stay for patients without complications was 61.84±31.75 hours (median 48), and for those with complications or death was 259.96±216 hours (median 120) (P<0.001). Except for two deceased patients, the majority of patients (95.1%) recovered without any complications.

Discussion

In the present study, the mean blood lead levels were compared for different GI symptoms in patients hospitalized for lead toxicity. The results showed that the highest frequency of hospitalization was in the age group of 30-60 years, and the majority (91%) were male patients. Irrespective of age, the blood lead level was higher in patients with multiple GI symptoms than those with a single symptom. In addition to GI symptoms, sensory disturbance was the most common neurological symptom. Overall, the majority of the patients (95%) recovered without any complications.

We found that abdominal pain in our patients was the most common GI symptom. Similarly, a previous study that only focused on abdominal pain reported a significant relationship between the degree of lead poisoning and the severity of abdominal pain.[12] Another study recommended lead poisoning to be considered in patients with a history of opium addiction presenting colicky abdominal pain.[8] GI symptoms due to lead poisoning can sometimes be severe and even occur with manifestations of intestinal obstruction such as the inability to pass gas or feces and prolonged vomiting. This was the case for some of our patients (14.6%) who therefore required surgical consultation. However, diagnostic imaging tests such as X-ray and CT scans confirmed non-mechanical obstruction, and abdominal surgery was ruled out. The patients were treated with water-soluble contrast agents such as meglumine compound. One of the patients with peritoneal sign of intestinal obstruction underwent laparotomy after which laboratory results showed high blood lead levels. Our results showed that blood lead levels were higher in patients with multiple GI symptoms than in those with a single GI symptom. Patients with multiple GI symptoms were three times more likely to have blood lead levels above 70 mg/dL. Therefore, an immediate blood lead test is recommended in patients with multiple GI symptoms. However, we found no published studies to substantiate our recommendation.

Neurological manifestations due to lead poisoning were also evaluated. The results showed that the majority of patients had no neurological symptoms. However, this does not dismiss the seriousness of high blood lead levels. Lead is the most toxic heavy metal, and prolonged exposure to lead dust or lead-based products in even low doses can cause serious health problems. The symptoms of chronic lead poisoning are non-specific and are associated with elevated blood lead levels. We did not observe other neurological symptoms such as seizures and coma in our patients. Animal studies have hypothesized the high risk of elevated blood lead levels in humans. However, the relationship between lead poisoning and central nervous system (CNS) disorders and seizures is disputed.[9] In our study, we did not assess the time between the initial onset of symptoms and hospitalization, which is a limitation of the study. We, therefore, do not know if the absence of CNS disorders, seizures, and coma in our patients with high blood lead levels was due to their early referral to the hospital and/or transient exposure to lead, i.e., less exposure to the CNS.

A number of studies have evaluated lead toxicity in patients with a history of opium addiction. In one study, blood lead levels in opium-dependent patients were compared with a control group. The results showed that the lead level in opium addicts was in a range of 69.9-7.2 µg/dL with a mean of 8.6±3.5, which was significantly higher than the control group.[10] Another study reported an average lead concentration of 1.88±0.35 µg/dL in 10 opium samples collected from different regions.[10] One case of oral opium use showed a blood lead level above 200 mg/dL and paralysis of the four limbs, which was not resolved even after treatment for intoxication.[11] In contrast, another study reported no significant relationship between opium use

and blood lead levels despite levels being higher in opium addicts than controls.[13] Although a history of drug abuse can be a risk factor for lead toxicity, we did not include this variable in our study.

As the main limitation, the single-center study design limits the generalizability of our findings. Another limitation is the fact that we did not assess the time between symptom onset and hospitalization. Besides, given the low number of female patients, further studies with a higher number of female participants are recommended to better understand the effect of sex on the clinical manifestations of lead poisoning.

Conclusion

Patients with multiple GI symptoms had higher blood lead levels than those with a single GI symptom. Given the prevalence of abdominal pain and its association with elevated blood lead levels, differential diagnosis of abdominal pain should include lead toxicity.

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Authors' Contribution

All authors contributed to the conception and design of the study, data collection/analysis/interpretation, and drafting and revising of the manuscript. The authors have read and approved the final manuscript and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest: None declared.

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