Clinical Case Report

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Lead poisoning in a 16-year-old girl: a case report and a review of the literature *(CARE compliant)*

Cristina Oana Mărginean, MD, PhD[a], Lorena Elena Meliţ, MD, PhD[a,*], Horaţiu Moldovan, MD, PhD[b], Vasile Valeriu Lupu, MD, PhD[c], Maria Oana Mărginean, Student[a]

Abstract

Background: Lead is a toxic element of the environment which leads to major complications once it enters the blood stream, affecting multiple organs and systems of the body.

Methods: We present the case of a 16-year-old girl, diagnosed with lead poisoning after occupational exposure due to the fact that the girl was actively involved in the family's pottery business.

History revealed that the girl participated in the process of pottery, her father was also diagnosed with lead poisoning 2 years before. The patient's personal history underlined that approximately 1 year ago she presented with severe abdominal pain, being diagnosed with acute appendicitis and she underwent appendectomy, but the pain persisted, thus due to family history of lead poisoning, the suspicion of saturnine colic rose, and she was diagnosed with lead poisoning. The main symptoms and signs were severe abdominal pain, vomiting, and arterial hypertension. The clinical evolution was favorable under symptomatic treatment and chelation therapy.

Results: Lead toxicity is a life-threatening condition because of its severe acute and chronic complications. In children, there is no safe blood lead level, prevention methods are, therefore, very important in order to avoid toxic multiorganic effects of this metal.

Conclusion: Even though the diagnosis of lead poisoning remains difficult in children, it must also be taken into consideration by the clinician facing a child with gastrointestinal or neurological involvement.

Abbreviations: ALAT = alanine-aminotransferase, ASAT = aspartate-aminotransferase, ATSDR = Agency for Toxic Substances and Disease Registry, CDC = control disease center, DBi = direct bilirubin, DMSA = dimercaptosuccinic acid, EDTA = ethylene diamine tetra-acetic acid, GGT = gamma-glutamyl-transferase, Hb = hemoglobin, Htc = hematocrit, K = potassium, MCV = medium cellular volume, Na = sodium.

Keywords: abdominal pain, child, lead poisoning, pottery

1. Introduction

Lead is a soft, pliable, bluish-grey metal resistant to corrosion, that exists in both organic and inorganic forms.[1] This metal does not conduct electricity and it owns antiradiation properties.[1] Lead poisoning in children is an important health problem, accounting for 0.6% of the global burden of the disease according to the World Health Organization.[2] According to the National Health and Nutrition Examination Survey data, from 2007 to 2010, approximately 535,000 children aged 1 to 5 years, meaning 2.6%, presented blood lead level above 5 μg/dL.[3] Even though lead is everywhere, the industrialized areas carry a higher risk for lead exposure.[1] The ways of contamination include ingestion, inhalation, prenatal exposure, and dermal exposure, but the most important and frequent ones are ingestion and inhalation.[1] The half-life of lead is between 30 and 40 days in men, while in children and pregnant women it can be longer.[1] It binds to the sulfhydryl group of proteins leading to toxicity for multiple enzyme systems.[1] The clinical presentation of lead poisoning involves nervous, hematologic, and renal systems impairment, but it can also lead to gastrointestinal disorders (anorexia, vomiting, constipation, abdominal pain), hypertension, and fertility impairment.[1] Neurological symptoms include ataxia, stupor, coma, convulsions, hyperirritability, reduced IQ, shortened attention span, increased antisocial behavior, reduced educational attainment, and even death.[1] Impairment of the hematological system may involve either disruption of heme synthesis or hemolysis, leading to anemia with its specific clinical signs, like weakness and fatigue.[1] The effects of lead on the renal system consist in proximal tubular function impairment leading to aminoaciduria, glycosuria, and hyperphosphaturia,[4] interstitial nephritis in chronic exposure, and also impairment of calcium metabolism by interfering with activation of vitamin D 1,2-dihydroxy cholecalciferol.[1] The diagnosis is established on the blood lead level, higher than 40 μg/dL for occupational and 30 μg/dL for nonoccupational exposure. Primary and secondary preventions should be the first steps in the management of lead poisoning as public health problem.[1] If a patient is found with

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[a] Department of Pediatrics I, [b] Department of Occupational Health, University of Medicine and Pharmacy, Tîrgu Mures, [c] Department of Pediatrics, University of Medicine and Pharmacy, Gr. T. Popa Iasi, Romania.

[*] Correspondence: Lorena Elena Meliţ, Department of Pediatrics I, University of Medicine and Pharmacy Tîrgu Mures, 38 Gh. Marinescu St., 540139 Tîrgu Mures, Romania (e-mail: lory_chimista89@yahoo.com).

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high blood lead level, the test must be repeated before considering any therapy. Chelating agents are recommended only if the level is above 45 μg/dL, and the type will be chosen according to the blood level and symptoms.[1] The available agents nowadays include: 2,3 dimercaptosuccinic acid (DMSA), dimercaprol, ethylene diamine tetra-acetic acid ($CaNa_2EDTA$), D-penicillamine. In certain cases, the management can also include supportive therapy, like airway protection in acute encephalopathy or antiepileptic drugs in case of seizures.[1]

We present a case report of lead poisoning in a 16-year-old girl with the aim of highlighting the difficulty in diagnosing this condition, and the fact that even though occupational exposure is the main cause of lead poisoning in adults by inhalation, it can also be present in children in certain circumstances, as in our case.

The informed consent was given by the patient's father (legal guardian) for publication of this case report.

2. Case report

2.1. Presenting concerns

We present the case of a 16-year-old girl, admitted to our clinic with severe abdominal pain, loss of appetite, nausea, and vomiting. The anamnesis revealed that the girl comes from a family of potters, and that she also participated in the process of pottery, her father being diagnosed with lead poisoning 2 years before. The patient's personal history underlined that approximately 1 year ago she presented with severe abdominal pain, being diagnosed with acute appendicitis and she underwent appendectomy, but the pain persisted, thus due to family history of lead poisoning, the suspicion of saturnine colic rose, and she was diagnosed with lead poisoning (urinary lead: 219 μg/L), but she received only symptomatic treatment. Approximately 3 weeks before admission to our clinic, she was admitted to the regional hospital with another episode of saturnine colic (blood lead: 113.2 μg/dL), and chelation therapy with EDTA (4 days before the admission in our clinic) was initiated, with a dose of 2 tablets daily, one in the morning and one in the evening associated with calcium supplements.

2.2. Clinical findings

The clinical examination performed at the time of admission revealed the following pathological elements: influenced general status, ailing face, jaundice of the sclera, blue pigmentation of the nails, painful abdomen at palpation, and weight: 45 kg.

2.3. Diagnostic focus and assessment

The laboratory test performed upon admission revealed hypochromic anemia (hemoglobin (Hb): 10.9 g/dl, hematocrit (Htc): 31.6%, medium cellular volume (MCV): 77.6 fL), increased level of liver transaminases (alanine-aminotransferase (ALAT): 158.9 U/L, aspartate-aminotransferase (ASAT): 63 U/L, gamma-glutamyl-transferase (GGT): 128 U/L), conjugated hyperbilirubinemia (direct bilirubin (DBi): 1.432 mg/dL), hyponatremia (Na: 132 mmol/L), and hypopotassemia (K: 2.85 mmol/L). The systolic arterial pressure was 156 mm Hg, and the diastolic was 96 mm Hg. The blood lead level was 66.28 μg/dL, the urinary one was 419.7 μg/L (normal <50 μg/L) and the value of delta-aminolevulinic acid was 7.66 mg/L (normal <4.5 mg/L). We also performed abdominal ultrasound which revealed a disappearance of the delimitation between the cortical and medullar parts in both kidneys. We requested consultation from an occupational healthcare specialist, who recommended the continuation of chelation therapy with EDTA, increasing the dose at 4 tablets/day. We also required a neurological consultation, and the specialist established the diagnosis of behavioral disorders with depressive elements, and recommended psychotherapy.

Based on all these clinical and laboratory findings, we established the diagnosis of lead poisoning.

2.4. Therapeutic focus and assessment

We initiated an intense i.v. hydration in order to favor lead elimination, approximately 3 liters per 24 hours initially, and we decreased progressively the quantity once she ceased to vomit, and she was able to consume liquids. We associated diuretics, initially furosemide by vein, but the values of the arterial pressure persisted above the upper limit, therefore we were forced to introduce also an angiotensin-converting enzyme inhibitor, with the remission of arterial hypertension. Regarding the liver function, we administered amino acids intravenously, associated with liver protectors by mouth. We also administered vitamins of the B complex in order to improve the neurological impairment. The evolution was slightly favorable, in the first 3 days after the admission, the patient continued to present severe abdominal pain, vomiting, and she also complained of pain in the lumbar area. All the laboratory parameters presented normalization of the values after approximately 10 days of treatment. On the 6th day of admission, we ceased the chelation therapy with EDTA. We also repeated the blood and urinary lead levels. The blood level was 45.57 μg/dL, and the urinary one was 836.4 μg/L before discharging the patient. The abdominal ultrasound reevaluation revealed no pathological modifications.

2.5. Follow-up and outcome

After 14 days of admission, the patient was discharged without any complaints, and we recommended no further exposure to lead, avoiding the contact and the working in the pottery process. The long-term outcome of this case depends on further exposure to this heavy metal. Nevertheless, we intend to repeat the blood lead levels after 12 and 24 months, assessing also the renal (urea, creatinine, urinary exam) and hepatic functions (ASAT, ALAT, GGT, bilirubin).

3. Discussion

Lead poisoning is a severe condition with potential multiorgan damage and even death if lead is present in large amounts in the blood, representing a major health problem.[1] In children, there is no safe lead level, although according to the World Health Organization, this problem represents approximately 0.6% of the global burden of disease.[2] The 2 main ways of lead poisoning are through ingestion and inhalation. The former is more common in children due to their tendency of chewing everything, while the latter is more frequent in occupationally exposed adults.[1] In the case presented here, lead entered the blood by inhalation as occupational risk due to the fact that our teenager patient had helped her parents in the pottery process. Other occupations with an increased risk for lead toxicity can be battery manufacturing and recycling plants, demolition, remodeling, and renovation projects, rubber and plastic industries, ammunition and manufacturing, automotive/ radiator repair, lead soldering and welding, painting, plumbing, and so on.[1]

There are certain storages of lead in the organism, such as bones, teeth, hair, and nails, where it is bound tightly and it does not seem to be harmful since it is not available to other tissues.[5] However in children, only 70% of the absorbed lead will end up in the bones, in comparison with adults in whom 94% will deposit there, fact that can be responsible for the more expressed clinical effects of this condition in small ages.[6] According to Lamas and collaborators, it seems that the deposit of active metals, like cadmium and lead, represents a major risk factor for cardiovascular disease.[7] Therefore, chelation therapy with edetate disodium can provide important benefits for those with atherosclerotic cardiovascular disorders.[7] Lead is well known as a risk factor for arterial hypertension.[7] The case we presented above also had increased values of arterial pressure. It seems that this metal is also incriminated for reducing the bioavailability of nitric oxide, and therefore promoting oxidative stress and inflammation.[7,8] A recent study assessed the relationship between blood lead levels and childhood asthma, 2 conditions frequently encountered in small children, both related to environmental factors. The study concluded that even though blood lead levels are not significantly associated with asthma diagnosis, the elevated blood levels of this metal lead to a more severe form of asthma in children, being related to eosinophilia and elevated immunoglobulin E levels.[9] The toxicity of blood lead levels on the nervous system is a major concern for children's normal development. According to the data of the Agency for Toxic Substances and Disease Registry (ATSDR), blood lead level in children is associated with encephalopathy.[10] Even though the results vary from study to study, it seems that a blood lead level of 70 to 80 μg/dL or greater represents a serious risk.[10] The neurological sequelae of lead poisoning include reduced IQ, shortened attention span, increased antisocial behavior, and reduced educational attainment.[1] It was proved that an average increase of blood lead level of 10 μg/dL in children will lead to an IQ decline between 1.9 to 3.2 points.[11] Other sequelae of chronic lead exposure consist in interstitial nephritis, reduction of sperm concentration, total sperm counts, and total sperm motility.[1] On a study performed on 769 American adolescents, Fadrowski found that decreased kidney function is positively correlated to a blood lead level less than 10 μg/dL, therefore the US government recommends repeated blood lead level testing at 12 and 24 months.[12] We also intend to repeat the blood lead level in our patient at 12 and 24 months. A study performed in developing countries showed that in many Latin American countries, lead-glazed ceramics represent a major source of exposure for those who live there.[13] Even though the most common cause of lead poisoning in adults is represented by occupational exposure,[14,15] in our case we detected elevated blood lead levels in a teenage girl after occupational exposure due to the fact that the patient supported the family pottery business. The pottery-making process involves ceramic glazes and decorative paints, which both contain lead. Therefore, these hand-made traditional products can represent a real danger not only for potters, but also for those using these products. The diagnosis establishment of this condition can represent a challenge for every physician, especially for a pediatrician due to the fact that the initial symptoms are nonspecific, such as abdominal pain, anorexia, or irritability,[1] suggesting a gastrointestinal pathology. The case presented above was also initially misdiagnosed as an acute appendicitis. Prevention of lead exposure is the most important step in lead poisoning management due to the fact that the neurocognitive damages induced by lead toxicity are irreversible,[13] and also because in children, this metal is much more easily stored than in adults and it impairs the function of multiple organs, such as kidneys, bones, blood, and the brain.[16] For example, in the United States, in 1988, control disease center (CDC) Childhood Lead Poisoning Prevention Program was created which provided local governments lead poisoning programs.[3] These programs include public health education, policy development, screening protocols, and case management guidelines.[1] We think that it would be of great importance for the potters to benefit at least from public health education about lead toxicity and screening programs for lead poisoning. The screening for lead poisoning would be an important diagnostic tool for the family members involved in the pottery process, diminishing the rate of unreported cases, and also due to the cluster occurrence of this condition. Due to the multiple system involvement, the management of lead poisoning presents multiple critical points. Therefore, the patient submitted to chelation therapy must be closely monitored, because even the elimination of this heavy metal itself can impair the renal function. Even though lead is a toxic metal that is easily stored in the body, its removal being almost impossible, chelation therapy remains the standard treatment of lead poisoning.[13]

4. Conclusions

Lead toxicity is a life-threatening condition because of its severe acute and chronic complications. In children, there is no safe blood lead level, prevention methods are, therefore, very important in order to avoid toxic multiorganic effects of this metal. Even though the diagnosis represents a challenge in case of children mostly due to its rare incidence in teenagers, a physician must always include this possibility in the differential diagnosis for cases with suggestive symptoms.

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