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CASE REPORT

Unintentional and Sequential Lead Exposure from a Ceramic Mug and Maca (*Lepidium meyenii*)

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Abstract
Although the incidence of lead poisoning has decreased in the USA over the last 30 years, human exposures to lead-containing products are still reported. We present a case of unintentional lead exposure from a store-bought ceramic mug and a nutritional supplement. A 32-year-old female was found to have a whole blood lead concentration of 44 μg/dL. Evaluation of her home, occupation, and hobbies initially did not identify a source of lead exposure. Further investigation revealed that the likely etiology of the exposure was lead leaching from a ceramic mug used by the patient to drink hot lemon water while she was pregnant. She stopped drinking from the mug and her blood lead levels decreased, but increased a year later after she began to ingest a maca root powder supplement. Upon discontinuation of maca root powder ingestion, her blood lead levels decreased further. Over time, the acidity and heat of the hot lemon water used in the ceramic mug enhanced the breakdown of its leaded glaze. Maca powder, which is available as a nutritional supplement and is used to treat fatigue and enhance fertility, may contain lead and other minerals. Consumers, particularly women of childbearing age, and their physicians should be aware that imported products available from commercial retailers and internet vendors may contain significant amounts of lead.

Keywords Lead · Maca · Supplement · Pregnancy

Introduction

Since the 1970s, improvements in health policies and increased public health education have reduced the incidence of lead poisoning in the USA [1]. Even so, elevated blood lead levels continue to be reported in all age groups. While lead-based paint is the most widespread source for lead exposure in the pediatric population, uncommon sources of exposure in all age groups include imported food products, medicinal supplements, and household items. In this report, we describe an unusual case of sequential lead exposures in an adult patient which occurred after use of a ceramic mug with peeling glazing, and imported maca (*Lepidium meyenii*) root powder.

Case Report

A 32-year-old woman was referred to an outpatient Medical Toxicology clinic due to an elevated whole blood lead level (BLL) of 44 μg/dL. The patient had blood lead testing performed because her infant daughter had an elevated venous BLL (9 μg/dL) on routine testing. On the patient's initial visit, her vital signs and physical examination were unremarkable. She complained only of daily headaches and occasional back pain. She reported that her daughter was growing normally and had met all of her developmental milestones. Additional laboratory testing, which included a complete blood count with differential, serum electrolytes, liver function testing, and urinalysis, was within normal limits. A urine pregnancy test was negative. A repeat BLL was ordered, and the patient was advised to return to the Medical Toxicology clinic in 2 weeks' time for further evaluation.

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A thorough evaluation of the patient's social status was conducted. Her past medical history was significant for hypothyroidism; this condition was managed by her primary care physician at a concierge-type medical practice. Her daily medications included levothyroxine, a probiotic, and multivitamins. She did not smoke cigarettes or use illicit drugs, and she rarely consumed ethanol. The patient lived with her husband and their daughter in an older, though recently renovated, house in an urban area that was supplied by city water system. Removal of leaded water pipes and installation of an instant hot water tap were performed by licensed contractors in the 2 years prior to the discovery of the elevated BLLs. The patient worked in an office building as the regional director for an international organization. She did not use imported spices, cookware, or cosmetics. She did not engage in hobbies such as pottery or painting. She had a remote history of firearm use but denied having internally retained shrapnel. She had breastfed her daughter but ceased this upon discovery of her elevated BLL. She reported that her pregnancy had been uncomplicated except for occasional constipation; her midwife had recommended that she drink hot lemon water as treatment. On a regular basis throughout most of her pregnancy, she consumed hot lemon water, made using her home's instant hot water tap, and drank from glazed ceramic mugs purchased from a common commercial retailer. She continued to occasionally drink the hot lemon water postpartum.

Subsequent to the discovery of the elevated BLLs, testing of the patient's home for lead was performed by an independent organization. X-ray fluorescence analysis of the home revealed the presence of lead-based paint in the home in areas that had been painted over by the contractors. There was minimal lead present in dust testing of the home. Examination of the ceramic mugs used by the patient to drink the hot lemon water revealed peeling of the glaze on the inside of the mugs. The home's tap water was tested by the local water utility service and was negative for lead. Due to the peeling that was noted on the ceramic mugs, the local water utility then tested a sample of the patient's hot lemon water (brewed in one of the ceramic mugs): this revealed the presence of lead on a qualitative assay. The patient and her husband then obtained private testing of the hot lemon water sample: atomic absorption spectroscopy analysis of the sample demonstrated significantly elevated concentrations of lead (4800–5900 μg/L, range < 15 μg/L), indicating that lead had likely leached from the ceramic mugs into the hot lemon water .

Upon receiving results of these tests, the patient discontinued use of the ceramic mugs. During subsequent follow-up appointments in the Medical Toxicology clinic, serial BLL measurements were ordered. Her BLL decreased dramatically over the next 3 months to approximately 10 μg/dL and then exhibited a slower decline after that (Fig. 1). She reported that her daughter continued to meet all of her developmental milestones. Due to the patient's desire to become pregnant again, she continued to follow up and had additional BLL testing performed through the Medical Toxicology clinic.

One year after her initial diagnosis, the patient began to ingest one teaspoon of maca root powder daily to treat fatigue. She had purchased the maca from an online retailer (Figs. 2 and 3). One month after she began to consume the maca, her BLL rose to 9 μg/dL. The maca was tested by the California Department of Public Health using graphite furnace atomic absorption spectroscopy, which revealed the presence of lead in the supplement (0.37 mg/kg, reporting limit 0.097 mg/kg). The patient discontinued her use of maca, and her BLLs trended downward. Approximately 19 months after her initial diagnosis, the patient's BLL reached a nadir of 4 μg/dL, and she was discharged from the outpatient Medical Toxicology clinic. Written consent for publication of this case was obtained from the patient and provided to the journal.

Discussion

Lead is a naturally occurring element in the environment but has no known biological role within the human body. Uncommon sources of inadvertent human lead exposure include imported foods, Ayurvedic medications, household items, and toys [1, 2].

Hot lemon water ingested from a lead-glazed ceramic mug is an uncommon etiology of lead exposure. Lead may be a component of pottery glazes and was likely present in the ceramic mug used by the patient in this case. Leaching of lead from ceramic and earthenware vessels has previously been reported as a source of lead exposure [3–5]. Lead oxide glaze, known as "greta," is commonly used in the manufacture of ceramic cooking vessels in Hispanic communities; use of imported lead-glazed ceramic dishes has been recognized as a risk factor for lead toxicity in Hispanic populations [6]. Over time, lead may leach out of pottery glazes; acidity and heat may increase the risk of this occurrence [1, 6]. In our case, the acidity of the lemon and the heat of the water used from the patient's instant hot water tap likely increased the rate of glaze breakdown and leaching from the ceramic mug, leading to lead exposure. As the ceramic mugs used in this case were purchased from a common US retailer, the patient was encouraged to report this finding to the Consumer Product Safety Commission.

Maca (*Lepidium meyenii*) is a plant endemic to Peru that grows at high altitudes and has an edible tuberous root, and is another uncommon etiology of lead exposure [7]. Ingestion of the maca root is reported to be effective against stress and fatigue, and maca has historically been used as a fertility enhancer by the Andes population [8]. Maca may contain minerals including iron, copper, and zinc, likely absorbed from the soil from which it was grown [8]. Although maca has not previously been reported to contain lead, use of other dietary

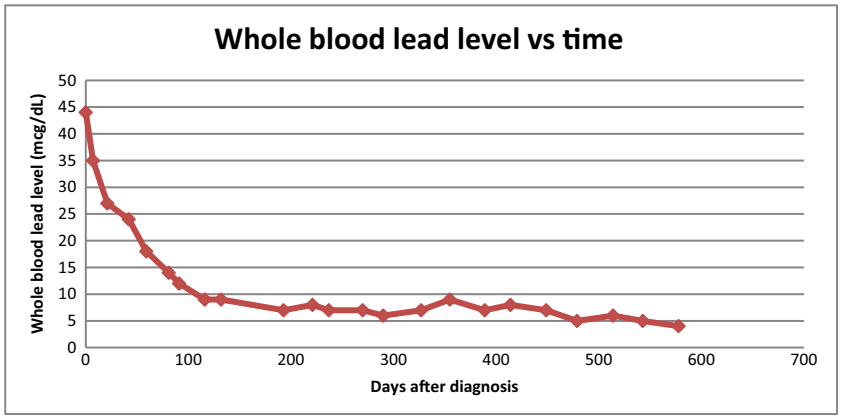

Fig. 1 Whole blood lead level vs time

supplements (including St. John's Wort and Ayurvedic or Chinese herbs) is associated with elevated blood lead levels among women [9].

Identification and elimination of the source of lead exposure is an important factor in resolving the exposure and toxicity [10, 11]. In our case, after recognition and elimination of the initial source, the patient's blood lead level initially decreased rapidly, followed by a slower decrease in concentration. This is explained by the multi-compartmental pharmacokinetics of lead. After absorption, lead enters the soft tissues and bone. The half-life of lead in the blood is approximately 1 month; however, absorbed lead can be stored in the bone for decades and will slowly redistribute from the bone compartment to the blood over time [11].

An important consideration in this case was the childbearing age of the patient. Her exposure occurred during pregnancy, and she wished to become pregnant again in the future. Although lead poisoning is rare in pregnancy, up to 1% of women of childbearing age have BLL's greater than 5 μg/dL [12]. Maternal lead exposure may lead to increased risk of spontaneous abortion when the BLL is greater than 5 μg/dL; for this reason, pregnant women (or those who desire to become pregnant) are often recommended to achieve BLL's less than 5 μg/dL [13, 14]. While the Centers for Disease Control and Prevention (CDC) and the American College of Obstetricians and Gynecologists do not recommend universal blood lead testing for pregnant women, identification and testing of at-risk pregnant women is advisable [12]. Risk factors for lead exposure in pregnant women include use of imported herbs, spices, or cosmetic products, participation in risky recreational activities (e.g., stained glass production, pottery, painting), or a personal history of previous lead exposure [12].

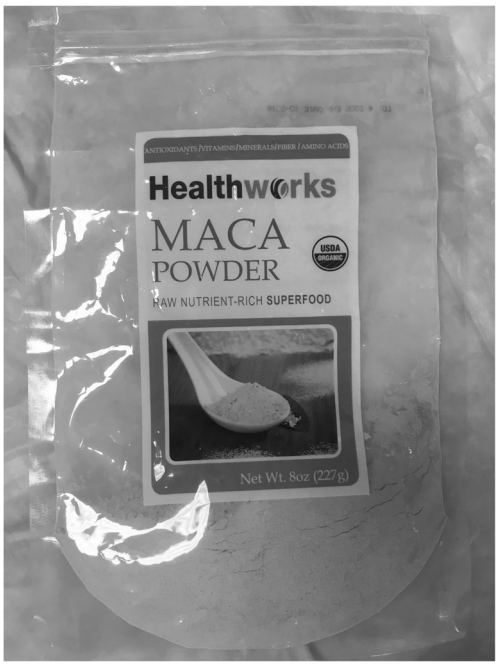

Fig. 2 Maca powder front view

Fig. 3 Maca powder back view

Conclusions

The use of maca root powder as a dietary supplement, as well as hot lemon water ingested from an old ceramic mug, represents two uncommon routes of lead exposure. In cases where the source of lead exposure is unknown, thorough evaluations of occupational, residential, and dietary practices may result in enhanced identification of the source(s) of exposure. Use of imported, handmade, or older lead-glazed ceramic dishes represents a significant risk for lead exposure and toxicity. Consumers, particularly women of childbearing age, and their physicians should be aware that imported products available from commercial retailers and internet vendors may contain significant amounts of lead.

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Compliance with Ethical Standards Consent for publication of this case was obtained and provided to the journal in accordance with JMT policy.

Conflicts of Interest None.

Previous Presentation of Data at Meetings or in Abstract Form None.

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