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CLINICAL CASE REPORTS

Presumed retinal lead poisoning: a case report

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Abstract
Purpose To describe a case of presumed retinal lead poisoning.
Methods Clinical examination, optical coherence tomography, fundus autofluorescence, fluorescein angiography, and electroretinography were used to study a 42-year-old male with the complaint of bilateral reduced vision following systemic lead poisoning.
Results The fundus examination showed venous tortuosity, as well as macular atrophy, and pigmentary changes in his both eyes. Optical coherence tomography revealed retinal thinning, outer retinal and retinal pigment epithelium atrophy, as well as foveal schitic changes. *Blue autofluorescence showed moderately hypoautofluorescence in peripapillary area of both eyes.* Fluorescein angiogram showed a leopard-like pattern of hypo- and hyperfluorescence in the posterior pole. Electroretinogram showed a moderate reduction in photopic and scotopic responses.
Conclusions The most probable diagnosis of this case is early onset retinal lead poisoning.

Keywords Retinal lead poisoning · Chronic lead poisoning · Retinal degeneration · Lead toxicity

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Background

Despite serious attempts to limit lead exposure, such as the elimination of leaded gasoline worldwide, it is still a health concern especially in developing countries [1]. The most amount of lead is absorbed in kidneys but the most prominent target for lead poisoning is the nervous system, specifically the sensory system [1, 2]. It is well known that structural and functional involvement of the eyes can occur in both acute and chronic exposure to lead [3–5]. Presenting signs and symptoms can vary from only structural findings in ocular imaging [3] to end-stage retinal degeneration [4, 6] depending on serum lead level, as well as duration and onset of lead exposure [1]. The purpose of this report is to describe a case of retinal degeneration probably due to Chronic lead poisoning.

Case report

A 47-year-old male presented with 5 months of reduced vision in his both eyes. He mentioned his symptoms which are worse at night developed acutely and had no progression in the last 5 months after documented lead poisoning. He denied any history of nyctalopia or visual symptoms prior to this.

His medical history included diabetes mellitus which was diagnosed 3 years ago and controlled with oral medication (metformin 1000 mg/day) with no diabetic retinopathy. Five months earlier, he was

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found to have chronic lead poisoning following investigations for weight loss, myalgia, and weakness. The workup found microcytic anemia and elevated liver enzymes and a serum lead level of 100 µg/dL (normal range of < 10 µg/dL). He was admitted and treated with two courses of five days intravenous sodium calcium edetate (disodium calcium ethylenediaminetetraacetic acid [EDTA]) for chronic lead poisoning. His serum lead level was 30.8 µg/dL one month after the end of treatment, his symptoms improved, and he did not need more treatment with chelating agents.

His family history was negative for systemic and ocular diseases. He denied any history of addiction or smoking, as well as occupational lead exposure, so the source of poisoning remained unclear.

On our examination, the best-corrected visual acuity (BCVA) was 7/10 in both eyes, with an IOP of 12 mm Hg and 14 mm Hg in right and left eye, respectively. The results of anterior segment examination were unremarkable. The dilated fundus examination showed venous tortuosity as well as macular atrophy and pigmentary changes in his both eyes (Fig. 1).

Color vision testing with Ishihara test was normal. Macular optical coherence tomography (OCT, Spectralis OCT, Heidelberg Engineering, Heidelberg, Germany) demonstrated retinal thinning, outer retinal and RPE atrophy, and foveal schitic changes in both eyes (Fig. 1). Blue autofluorescence (Heidelberg Engineering, Heidelberg, Jena, Germany) was unremarkable in the posterior pole but showed moderately hypoautofluorescence in peripapillary area of his both eyes (Fig. 1). Intravenous fluorescein angiogram showed a leopard-like pattern of hypo- and hyperfluorescence in the posterior pole in his both eyes (Fig. 1). Full-field electroretinography (ERG) was performed using the MonPack3 system (Metrovision, Pérenchies, France) following the protocol established by the International Society for Clinical Electrophysiology of Vision (ISCEV) and revealed a moderate reduction in scotopic response and moderate to severe reduction in photopic responses in his both eyes (Fig. 2).

In the last follow-up visit, four months after presentation, the BCVA was 6/10 in both eyes and slit lamp, fundus examination as well as macular OCT remained unchanged. Visual field perimetry was performed with Standard Swedish Interactive Thresholding Algorithm (SITA) with the 24–2 pattern on the humphrey field analyzer (Carl Zeiss Meditec) and demonstrated bilateral blind spot enlargement (Fig. 3).

Discussion

Lead is the oldest and best-studied environmental toxicant and exposure whether is acute or chronic, results in cardiovascular, neurological, hematological and immunological pathologies [1]. In respect of the eye and visual system, it has been shown that frank (mean blood lead concentrations [BPb] ≥ 80 µg/dL) and moderate ([BPb] 40–80 µg/dL) lead poisoning can cause both structural and functional injuries [1, 3].

Structural injuries in the eye include decreased macular, choroidal, and retinal nerve fiber layer thickness [3], cataract formation [7], pigmentary lead deposits in the optic disc margin periphery [8], optic neuritis or atrophy [9, 10], oculomotor deficits [1], retinal degeneration [4], as well as increasing the risk of age-related macular degeneration [11] and primary open-angle glaucoma in females [12].

Functional injuries include ERG alterations such as decreased sensitivity and amplitude of a- and b-waves of dark-adapted retinograms [13], increased latency of VEP waves [14, 15] and blue-cone color vision deficits [16]. Lower concentrations of blood PB (35–47 µ/dL) result in decreased critical flicker fusion threshold under scotopic conditions, but not under photopic conditions but concentrations of blood PB (≥ 49 µg/dL) cause decreased critical flicker fusion threshold when tested under mesopic to photopic conditions [1]. The more severe reduction in photopic than scotopic responses in our case may be due to the high blood lead level but remains as a question to answer in more comprehensive studies.

Our case presented with recent visual problems that did not progress during past months; ocular imaging demonstrated bilateral macular atrophy, as well as diffuse photoreceptor and RPE loss. At the time, our differential diagnosis included end-stage retinal dystrophies such as cone/cone rod dystrophy and Stargardt disease, vitreoretinal degeneration of X-linked retinoschisis (XLRS) and lead poisoning.

Cone and cone rod dystrophies (COD and CORDs) are described as macular disease or as diffuse retinopathy with predominance of the macular involvement which results in progressive central vision loss, photophobia, and color vision abnormalities in childhood

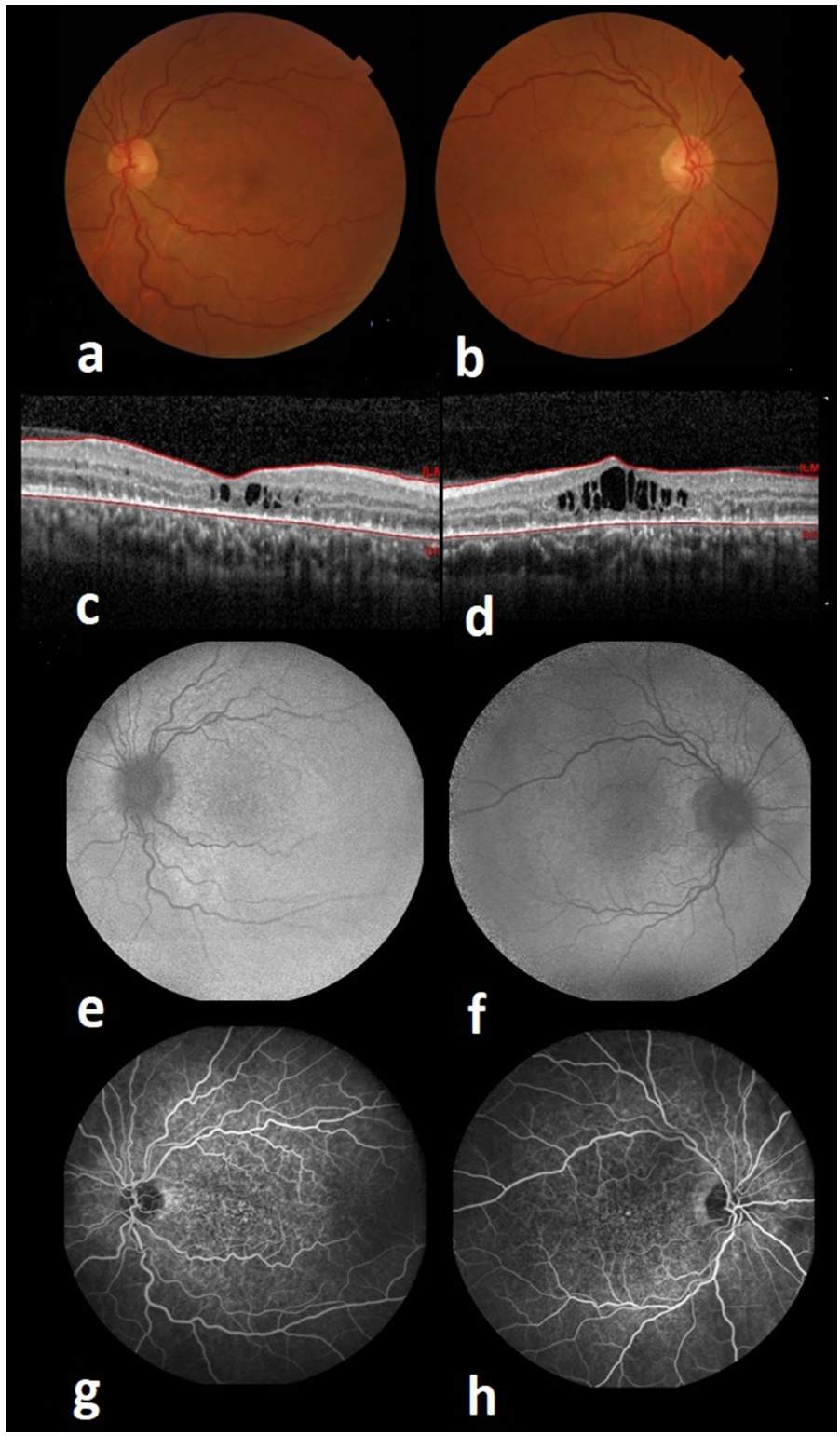

Fig. 1 **a** and **b** fundus examination revealed venous tortuosity as well as macular atrophy and pigmentary changes in both eyes, **c** and **d** corresponding foveal horizontal OCT b-scans showed bilateral retinal thinning, outer retinal and RPE atrophy, and foveal schitic changes, **e** and **f** blue autofluorescence demonstrated peripapillary hypoautofluorescence OU, **g** and **h** fluorescein angiogram showed a leopard-like pattern of hypo- and hyperfluorescence in the posterior pole of both eyes.

or early adulthood [17]. In most cases, patients develop secondary rod system involvement that leads

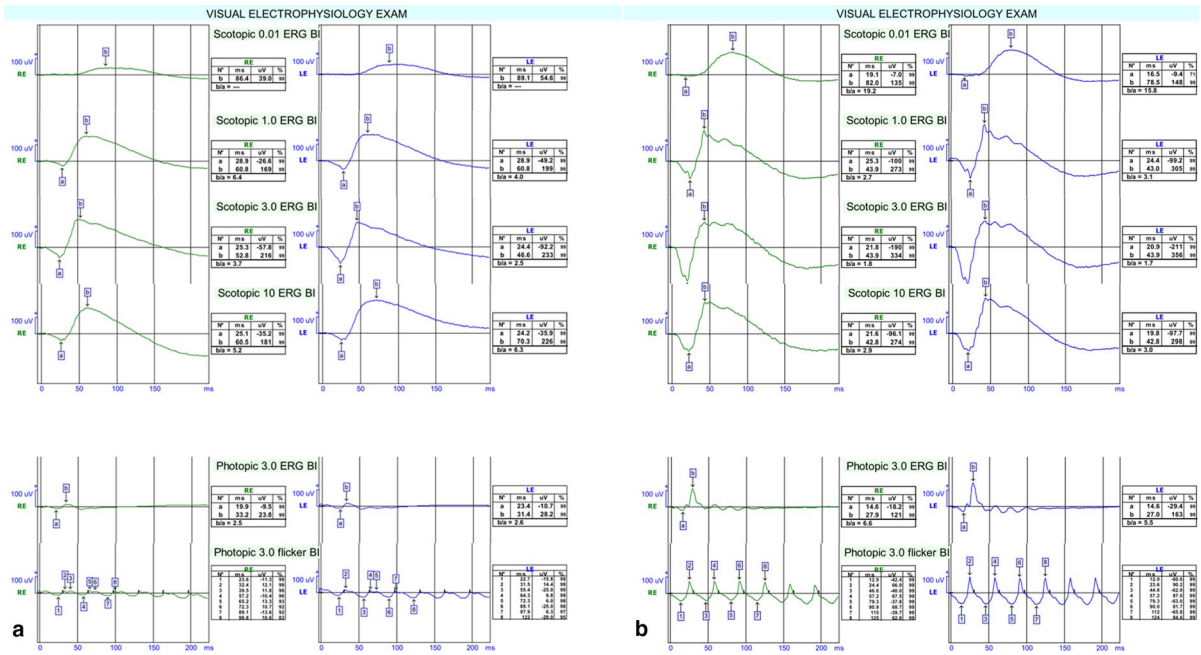

Fig. 2 Full-field ERG revealed a symmetric moderate reduction in photopic and scotopic responses (**a**) in comparison with normal ERG responses of a 45-year-old adult (**b**)

to night blindness and peripheral visual field defects but in some cases, diffuse retinopathy affects simultaneously cones and rods, resulting in both night blindness and loss of visual acuity [18]. The characteristic fundoscopic feature of COD/CORDs is "bull's eye maculopathy" but it may be present in less than 10% of patients; the most common fundus patterns is extensive retinal atrophy (36%) followed by macular atrophy (34%) and macular RPE alterations (21%) [17]. The first sign of CRDs On OCT is an absent interdigitation but in advanced disease, outer retinal and RPE atrophy is observed [19]. ERG shows dramatic decrease in both a- and b-waves amplitudes with predominant involvement of photopic over scotopic response [18]. This diagnosis was less probable in our patient due to acute visual loss in middle age after documented history of lead poisoning, unrelated parents, and fair visual acuity (7/10) with preserved moderately of ERG response despite diffuse outer retinal atrophy.

Stargardt disease is the most common inherited macular dystrophy with a significant variability in different characteristics for example the retinal flecks may not be present in early and late stages of the disease or even at all [20–22]. It has been suggested that adult-onset or the later onset 'foveal-sparing' form of the disease is the more benign form compared with childhood-onset form [21], but they also may manifest variable phenotypes [23]. According to ERG patterns reflecting the severity of functional loss, there is a classification proposed by Lois et al.: Group 1 with severe pattern ERG abnormality (macular dysfunction) and normal full-field ERGs; Group 2 with additional generalised loss of cone function; and Group 3 with additional generalised loss of both cone and rod function [24]. This diagnosis cannot be ruled out without genetic testing but is unlikely for our patient because usually the abnormal ERG in Stargardt disease is accompanied with more reduction in central visual acuity.

X-linked retinoschisis is the most common type of juvenile onset retinal degeneration in males which is mostly diagnosed at school age [25]. The typical features include mild-to-severe loss in central vision, foveal and peripheral schisis, and a negative electroretinogram (ERG) but course and severity are highly variable even within families or between two eyes of a patients [26]. Although the foveal schisis is present in 98–100% of patients, the typical sign of a spoke-wheel pattern of folds radiating out from the fovea

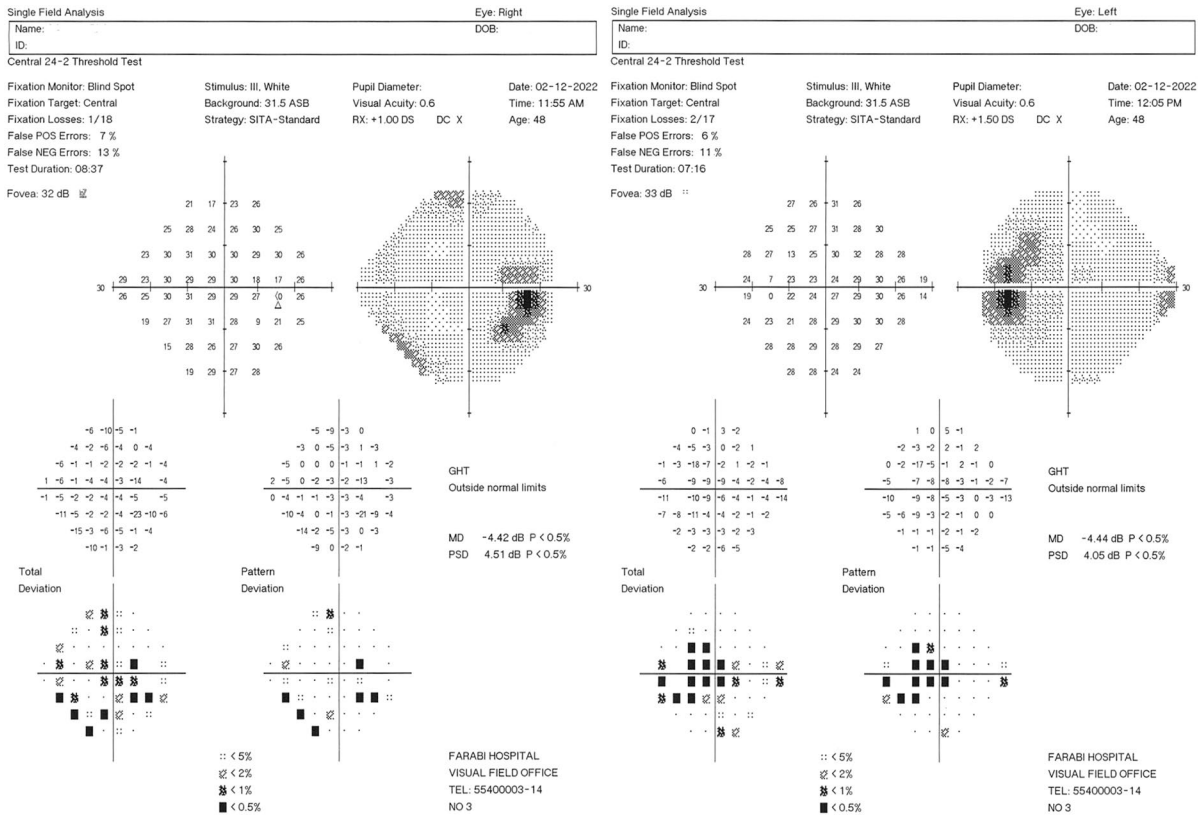

Fig. 3 Visual field perimetry showing enlargement of blind spot in both eyes

may not be present in about 30% of cases or may become less distinct [25, 27]. Peripheral retinoschisis and negative electroretinogram are also not present in around half of the patients [26].

Considering the subacute onset right after lead poisoning, the stable course of symptoms after the treatment of lead toxicity, as well as negative family history of retinal disease, we presumed the chronic retinal lead poisoning as the most probable diagnosis of our case. In addition, bilateral peripapillary hypoautofluorescence associated with blind spot enlargement could be indicators of toxic optic neuropathy. However, in the absence of genetic testing for hereditary retinal dystrophies and degenerations, they cannot be completely excluded. There are evidences of photoreceptor damages and late onset retinal degeneration in patients with chronic lead exposures [4, 28, 29] or late onset visual system deficit following acute lead exposure (6) but to the best of our knowledge, this is the first case of early onset retinal degeneration following chronic lead poisoning.

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Declarations

Conflict of interests The authors declare that they have no conflict of interest.

Consent for publication Written informed consent was obtained from the patient for publication of this case report and any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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