CASE REPORT

Unusual mercury poisoning from tattoo dye

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Abstract

Background: Tattoos have become very popular in modern societies due to the gradual change in aesthetics and psychosocial acceptability. Consequently, tattoo reactions are seen more commonly than in the past. Cutaneous lesions associated with tattoos can be divided into three major groups: allergic/granulomatous/lichenoid, infectious, and coincidental lesions. Early identification and proper treatment of these skin lesions is challenging and necessitates close cooperation of different medical specialties.

Case description: We report an unusual case of mercury poisoning in a young person manifested with local skin reactions following amateur tattooing. The tattoo induced inflammatory foreign body reactions and required multiple surgical excisions to be removed. The unique feature of this case is the use of the elemental form of mercury in the tattoo dye and the resulting mercury poisoning. The poisoning was confirmed by detection of mercury in blood, urine, and hair samples.

Conclusion: This is a rare case of tattoo-associated skin reaction and mercury poisoning by the elemental form of mercury contained in the tattoo dye. In the literature, many conditions have been documented in association with tattoos and the process of tattoo application, especially when red dyes are used, but no similar cases of elemental mercury poisoning from the tattoo dye exist. HIPPOKRATIA 2017, 21(4): 197-200.

Keywords: Tattoo reaction, mercury poisoning, tattoo mercury dye, tattoo complications

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Introduction

Mercury is a metallic element with natural deposits in the environment that can be found in nature in several forms, which are well-known since antiquity. Mercury can be used as metal form (Hg^0), in the form of inorganic compounds of monovalent (Hg^+), or bivalent (Hg^{+2}), or in the form of organic compounds, the latter being more interesting in toxicology.

In general, currently there are reported to be approximately 3,000 applications of mercury and its compounds, therefore, the probability of mercury poisoning cannot be considered negligible. Mercury has been used, for example in the industry for the production of thermometers, batteries, switches, manometers, X-ray bulbs, as well as, filling materials in dentistry. Also, mercury sulfide or cinnabar (HgS) constitutes one of the main ingredients in the manufacturing of red dyes used in tattoo application. The use of mercury in tattooing can be considered as a single dose of exposure to a toxic substance[1]. It must be noted that mercury sulfide causes irritation of the epidermis that cannot be clinically differentiated from eczema[2,3].

The purpose of this paper is to describe the unusual case of mercury poisoning manifested with local skin reactions in a young person following amateur tattooing. The poisoning was confirmed by detection of mercury in blood, urine, and hair samples.

Case report

We report the case of a 14-year-old male adolescent who underwent amateur tattooing to his left arm which was reported to have completely disappeared after three weeks. He reported that 20 days later he developed persistent inflammation and erythema in the arm, which he initially attributed to accidental scalding with hot water. He was initially administered a course of oral antibiotics (amoxicillin/clavulanic acid 500/125 mg, three times daily for ten days), without any improvement of the local symptoms. Subsequently, he was admitted to a general hospital in Athens where he was treated with intravenous (IV) antibiotics. The inflammation subsided without completely disappearing. He was submitted to plain X-ray imaging of his arm, which showed multiple confluent subcutaneous radiopaque deposits in the soft tissues of the arm (Figure 1). When the lesions were incised, metallic foreign bodies were found which were examined and verified macroscopically by the laboratory of the Polytechnic of Crete, to be metallic Mercury. At the request of the attendant physician, the Forensic and Toxicological Laboratory of the Aristotle University of Thessaloniki proceeded with an investigation for detection of mercury

Figure 1: Plain X-ray imaging of the arm of the adolescent who underwent amateur tattooing showing multiple confluent subcutaneous radiopaque deposits in the soft tissues of his arm.

Figure 2: Photograph demonstrating incision and surgical drainage of the cutaneous lesions. Metallic foreign bodies (metallic Hg globules) are noted on the gauze swabs.

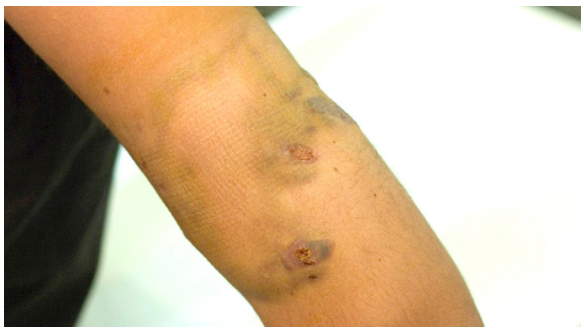

Figure 3: Photograph of the arm of the adolescent who underwent amateur tattooing showing his clinical presentation with skin lesions consisted of ecchymoses, granulomatous-like, crust-covered ulcers, dermatitis-like circumscribed plaques, and skin areas with deep depressions.

in biological samples of whole blood, urine, and hair. There is no report that he had eaten fish in the preceding days neither to have undergone any dental procedure. A biopsy of the lesions was not performed at that time. The blood and urine analyses were repeated three months later. During this period, the patient had undergone several surgical procedures to remove the mercury particles (Figure 2).

Upon his presentation at the hospital, he underwent a dermatological consultation. The skin lesions on his left arm consisted of ecchymoses, granulomatous-like, crust-covered ulcers, dermatitis-like circumscribed plaques, and skin areas with deep depressions (Figure 3). Palpation revealed cobblestone-like nodules subcutaneously. He reported experiencing mild pain or discomfort during regular activities and palpation, despite its clinical appearance. The two possible diagnoses were foreign body reaction and chronic subcutaneous infection. The latter was precluded from the history and the microbiology cultures of the draining material, that were negative for pathogenic bacteria.

Due to the unusual presentation, forensic evaluation of the case was requested which, based on the history and clinical examination, reported two inflicted injuries on the left arm as craters with well-circumscribed margins from the surrounding skin, and multiple ecchymoses around these wounds. These were considered as wounds and contusions resembling an open rupturing trauma, rather than pin or cut wound. Based on these findings, we excluded the possibility of a thermal burn from a liquid (e.g., boiling water), as per patient's and his relative's claims.

The collected biological samples (one ml of whole blood, two ml of urine, and 500 mg of hair) were subjected wet digestion, using with a mixture of concentrated acids (nitric, hyperchloric and sulphuric acid) at a temperature of 40 ^{o}C for 60 minutes and finally for 180 minutes at 90 ^{o}C. The residue was reconstituted by a mixture of concentrated nitric and hydrochloric acids (1:5 v/v). Then, mercury was determined by cold-vapor atomic absorption method. Flame atomic absorption is a common technique for detecting metals, but in this case, was not recommended due to its relatively poor sensitivity and the high volatility of the metal respectively[4]. The cold vapor atomic absorption method is a suitable technique for mercury analysis and has been used successfully for mercury determination in blood and urine[5,6], and hair samples[7]. Hence, the cold vapor determination of mercury using atomic absorption spectroscopy was considered the method of choice due to its sensitivity and specificity. In this method, mercuric ions were reduced to elemental mercury atoms using a reductant (25 % by weight stannous chloride in 20 % HCl)[8]. A Varian SpectrAA-300, Atomic Absorption Spectrometer, equipped with a Varian Model 77, Vapor Generation Accessory, was used for mercury determination in the biological samples. All the chemical agents (HNO_3, HCI, $HCIO_4$, H_2SO_4) were analytically pure. At this point, it must be noted that in the

biological samples that were analyzed, concentrations of metallic mercury were found, while the red coloring of the tattoo consisted of mercury sulfide. Consequently, by some process, the Hg^{2+} was reduced to Hg.

For the calibration curves, used in mercury determinations, we analyzed with the same analytical procedure, blank whole blood and urine samples, as well as whole blood and urine mercury-free samples, spiked with the metal in concentrations of 20, 50, 100, 200, 300 μg/L respectively[2].

In the first blood sample, we found a concentration of 218 μg/L, which is ten times the normal concentration (<20 μg/L) and the respective quantity of Hg in 24-hour urine was 5,400 μg. The second blood sample, after the removal of metallic mercury from the arm, had a mercury concentration of 112 μg/L, about half of the respective first sampling value, but it was still elevated. A mercury blood concentration up to 20 μg/L is considered as normal[9].

The daily urine excretion of mercury in both the collected samples was significant; 5,400 μg/day in the first sampling and 580 μg/day the second, respectively. There was a decrease of the daily Hg excretion approximately ten times between the two samples, but the second concentration (580 μg/day) was still high and indicated a significant exposure. The Hg concentration of 50 μg/24 hours in urine usually is the lowest at which symptoms of poisoning may appear[10].

Discussion

Tattoo inks are extremely slow-release formulations; their elimination takes place over the years, a process influenced by many factors, such as epidermal changes, redistribution of pigment in the skin, and dermal fibrosis[1]. Cutaneous reactions to tattoo inks can be classified into three major groups: allergic, infectious, and coincidental[11]. All kind of tattoo dyes have been reported to cause reactions: black, red, green, and yellow dye. Reactions to temporary black tattoos are common[12] but rather rare to permanent black tattoos[1,3]. When an allergic reaction to black tattoo is observed, usually initiates within a variable time interval, from weeks to months. Histologically, it is a foreign body or epithelioid granulomatous reaction. Infectious complications occur earlier, within 4-22 days and the clinical manifestations range from small pustules and superficial cellulitis to deep abscesses[11].

The kind of reaction in the reported patient was a foreign-body reaction to the particles of elemental mercury. The delay between tattooing and the reaction was rather short for a delayed-type allergy, and there was no history of previous sensitization. The resulting formation of abscesses and fast skin elimination of this specific tattoo dye, in contrast to the usual slow chemical breakdown, also confirms this fact[11].

Whole blood mercury levels are reflective of acute inorganic, and elemental mercury exposure and normal levels are less than 20 μg/L[9]. Mercury is excreted in the urine, and 24-h urine specimens for the measurement of mercury are essential. Detection of mercury in the blood (B-Hg) is a good indicator of recent exposure, while urinary detected mercury (U-Hg) indicates current exposure when the mercury reaches the renal clearance steady state[13]. According to the recorded results of the first and second analyses, the concentration of mercury in the blood, despite being higher than the accepted concentrations (<20 μg/L)[9], decreased from 218 μg/L to 112 μg/L; probably due to the surgical removal of the elemental mercury performed in between the two samplings but also due to the half-life time of mercury, which is 40-60 days[9,14]. Should the mercury particles had not been surgically removed, due to its gradual absorption, the blood levels could have been stable or elevated for the next few months. Additionally, the recorded reduction of mercury concentration in blood within three months is calculated to a half-life of approximately 90 days, exceeding the published half-life values for mercury. Possibly, microscopic particles of the elemental mercury remained in the body and were subsequently absorbed and excreted. It is important to recall that blood, hair, and urine mercury levels reflect a recent exposure and do not correlate with total body weight and this case is a recent mercury exposure[14].

Currently, tattoo inks are free of mercury and cadmium, which in the past caused allergies, especially tattoo dyes made with cinnabar and cadmium sulfate used for decades as inorganic pigments[1]. Mercury sulfide is considered responsible for eczemas, photoallergic reactions, severe inflammations, and for this reason, it tends to be replaced by other tattoo dyes that do not contain mercury sulfide[15].

The unique feature of the reported case contributing to the relevant literature is the use of the elemental form of mercury in the tattoo dye and the consequent mercury poisoning and foreign body reaction which necessitated multiple surgical incisions to be completely removed. In the literature, there is no similar report of mercury poisoning from tattoo dye, except only for a variety of skin symptoms[16-18]. Several cases of side-effects have been reported in individuals who had tattoos with red dye[3].

The increasing popularity of tattoos has created the need for awareness and early diagnosis of tattoo-related cutaneous lesions, especially in primary care physicians. The proper treatment of these skin lesions is challenging and necessitates close cooperation of different medical specialties. Also, as toxicological knowledge advances, the study of biokinetics and safety profile of the plethora of tattoo pigments is essential. Inks contain many ingredients, both soluble and insoluble, and possible contaminants. The toxicological research and evaluation of the different biochemical characteristics of absorption, distribution, metabolism, and excretion of the variety of pigments will help in the future to define more accurately the risk of this single-dose intoxication process.

Conflict of interest

The authors have nothing to declare.

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