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OCCUPATIONAL TOXIC ALOPECIA DUE TO BORAX

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Abstract. A man aged 50 years presented alopecia due to occupational contact with borax. This case report is preceded by a description of the clinical symptoms of intoxication with boron compounds. The fatal dose of boric acid in man is unknown but absorption of boric acid from a saturated solution through the intact skin is possible. A solution of borax in water might also permit absorption. Boron is excreted very slowly by the body. Accordingly, accumulation in the tissues might occur. The author discusses the factors that might have given rise to the toxic symptoms due to borax in this patient.

Intoxication by boron compounds manifests itself clinically in the skin.

The cutaneous symptoms nearly always begin with erythema, local or generalized (erythroderma). The entire skin, including the palms of the hands and the soles of the feet, takes on a lobster-red color. It is also possible for the erythema to present a macular or urticarial aspect, associated with vesicles or papules. Desquamation follows soon afterward (5). The erythematosquamous picture may show great similarity to psoriasis, for which reason the term "psoriasis borica" is sometimes used (11). Occasionally the desquamation is so pronounced that the picture of exfoliative dermatitis develops. Watson (28) described the "boiled lobster" appearance. Wong et al. (29) in a series of 11 children with boric acid poisoning observed an initial erythema of the perioral and perineal regions and the buttocks.

The mucosae may also be affected. These may grow red and dry and develop desquamation.

The hairs may also show alterations. They grow dry and fall out. Such alopecia is usually diffuse, but is sometimes more pronounced in some areas than in others. It may extend to the eyebrows, axillary and pubic hair and may ultimately become complete (6). The nails may also change, growing white and crumbly (12).

There are gastrointestinal symptoms with nausea, vomiting and diarrhea; the diarrhea may sometimes contain blood. A typical aspect in children is a bluish-green color of the vomit and feces. Gastrointestinal symptoms have been reported after local application to the skin of powder or ointment containing boric acid (2). There can be increasing nervousness, restlessness, headache, muscle pains and listlessness. The damage to the central nervous system, for which boron appears to have considerable affinity, may lead to symptoms of meningeal irritation such as convulsions, delirium and coma (10). Children may also exhibit intensified reflexes, opisthotonos and an anxious facial expression (29).

The kidneys may also be damaged, leading to disturbances of the renal function and abnormalities of the urine (16, 17). Hypernatremia, hyperchloremia and metabolic acidosis have been described (18, 19).

Finally, hemorrhagic diathesis may occur with purpura; the patients growing anemic and cachectic.

No cases of alopecia due to occupational borax poisoning appear to have been reported in the literature although many case reports refer in passing to alopecia after administration of borax or other boron compounds for medical purposes.

CASE REPORT

History. In December 1967 a man of 50 years reported to the dermatological policlinic with the complaint that in the last week his scalp hair had fallen out very markedly during washing. He said that increased loss of hair had been observed for 3 months, most marked shortly before he came to the clinic. He also had other complaints. Some 6 months previously he felt very nervous and excited, suffered from insomnia and attacks of headache with pyrexia and frequent muscle pains, especi-

ally in the extremities. A week after the increased loss of hair, his face and head grew red and flaky.

Condition on examination. On examination we observed a patient in moderately good health, somewhat lean. The most striking feature was a diffuse loss of hair, the alopecia being marked in the medial region of the head. The beard growth had decreased markedly in the last few weeks. The skin of the face and head exhibited a slightly diffuse, white desquamation against an erythematous background, with a psoriasiform aspect.

He had no gastrointestinal disorder, no nausea or vomiting. Recently, his appetite had decreased, but there was no marked loss of body weight. There was no hepatic or renal disease and no psychiatric disorder. The blood picture and SR were normal. The Wassermann test was negative.

Diagnosis. Alopecia after infectious disease or due to a toxic agent.

Further investigations. The patient had never suffered any skin lesions. He used no drugs, drank moderately and smoked one packet (about 3.5 oz) of shag tobacco per day.

There was no record of atopy either in the patient's history or in that of his family. The patient had never suffered from bacterial or fungal infection.

He worked as a storekeeper. One of his duties was to fill almost daily with washing powder a dispenser hanging near a lavatory basin. He had done this for more than 6 years. The washing powder was stored in a drum with a capacity of about 50 kg standing in the store room in a basement with almost no ventilation. The washing powder was finely granular and the patient frequently had to sneeze several times as he could not avoid inhaling some of it while filling the dispenser. The principal components of this washing powder with a pH of 9.2 were: 78.6% crystalline borax ($Na_2B_4O_7 \cdot 10\ H_2O$), 19.1% fatty acids, 20.6% soap of anhydrous soda.

By now we suspected a connection between the alopecia and the borax. We advised the patient to avoid all contact with the washing powder. All symptoms, including the loss of hair, subsided. This is a typical finding of chronic boron intoxication.

We demonstrated boron in the urine 6 weeks after discontinuation of the contact: the urine was acidified with dilute HCl and concentrated by evaporation. Turmeric paper was moistened with this concentrate. It turned a reddish brown color on drying. After moistening with ammonia, this color changed to greyish-blue. The test was repeated with urine from a healthy person. This test gave a negative result. Subsequently, 5% boric acid was added to this urine sample, which then gave the same reaction with the turmeric paper as our patient's urine. One week later, we repeated the test with the patient's urine. Once more, the turmeric paper showed the same color change with approximately the same intensity.

A few months later, when the patient's hairgrowth was more or less normal, we once more tested his urine for borax. No borax could then be demonstrated with turmeric paper. This shows how extremely slowly borax is excreted by the body. Féré (6) reported that in a patient treated with a dose of 10 g borax per day borax could be demonstrated in the urine until the 41st day after the discontinuation of treatment; in another case, even after 53 days, although initially the borax is excreted very rapidly, e.g. 25 min after ingestion of a solution of 4 g. At that time, borax can be demonstrated very clearly in the urine.

It is of interest to note that no cases of this nature have as yet been observed in industry, although boron compounds have a great many applications.

DISCUSSION

Borax, or sodium borate, was originally imported into Europe from Persia, China and Japan, under the name of Tinical or Tinkar. In 1776 a store of relatively pure boric acid was discovered in the warm springs of Tuscany. In 1856, large quantities of borax were found in a mountain lake in California, where extensive deposits were also encountered in Death Valley. This is still a principal source (25).

Borax is soluble in water. It is alkaline (pH = 9.2) and is marketed in the form of crystals, granules and powder. Owing to its capacity of dissolving metallic salts and giving these salts their characteristic colours, it is applied in glass, enamel, ceramic and metallurgic industries. Sodium metaborate is used in glues and in photography. Boric phosphate is used in the manufacture of china and of optic glasses.

Esters of boric acid are soluble in organic fluids and are used to bind boron in, for example, paint, plastics and bitumen. Other boron compounds are used in industry as anticorrosives in anti-freeze and in the manufacturing of leather goods, hats, rugs and cosmetic articles; it is present in detergents and soap; it is used in rendering wood impermeable to water and in fireproofing various materials (21). Boron compounds are present in certain foodstuffs such as vegetables and fruits (especially currants, raisins and orange juice), bread and wheat products. The normal mean concentration in the blood is 0.14 mg per 100 ml of blood (0–0.72 mg) (27). See also (1) and (28).

Cases of boric acid poisoning show that a fatal outcome is fairly frequent. At least 17 fatal cases of boric acid poisoning were reported up to 1926, as compared to 36 cases in which the patient's life was saved. In ten important reviews which

appeared between 1940 and 1950, Ross & Conway (22) described 27 cases of which 20 had a fatal course. MacNally & Rukstinal (17) collected 58 cases, of which more than 50% were fatal.

In 1953, Goldbloom & Goldbloom (19) found a death rate of 70.2% in children younger than 1 year in 109 cases of boric acid poisoning. In the most recent survey of cases of boric acid poisoning published by Valdes-Dapena (27) 172 cases are described of which 85 were fatal. The lethal dose of boric acid in man is unknown. The findings reported by different authors vary very widely. Abnormally high boric acid levels of the blood, which might have fatal consequence, varied according to Ducey & Williams (4) between 2.2 mg and 29 mg per 100 ml. Wong et al. (28) in 5 fatal cases of boric acid poisoning in children observed levels between 20 and 160 mg per 100 ml. According to Caujolle (1), an adult could tolerate 4 g boric acid orally per day without danger, but a single dose of 18 to 20 g would be fatal. For a child, this level would be 5 to 6 g.

MacIntyre & Burke (13), on the other hand, described an adult patient who was given a subcutaneous infusion of a fluid that contained 15 g boric acid and who exhibited only slight symptoms of intoxication. Another adult patient presented only flushing, nausea and vomiting after intravenous administration of 600 ml of a solution of 2.5% boric acid.

Boric acid from a saturated solution is thought to be absorbed to some extent by the intact skin. Kahlenberg (15) demonstrated this by having volunteers take footbaths consisting of a saturated solution of boric acid. Boric acid could be demonstrated in the urine within 5 min. Experiments have also been carried out in animals. Mulinos et al. (16) observed an increased excretion of boric acid in the urine of rabbits and dogs after application of saturated solutions of boric acid to the intact skin. They also observed that boric acid in talcum powder can be absorbed in a sufficient degree to give rise to toxic symptoms. This observation was later confirmed by Skipworth et al. (26) who reported a case of boric acid poisoning after use of "medicinal" talcum powder. The patient was a boy of 3 years who for 3 months had been treated several times per day with "medicated talcum powder". The product contained boric acid. The child was hospitalized with fever, anorexia, oliguria, irritation of the CNS, tonsillitis and exfoliative dermatitis. Freimuth & Fisher (7) carried out their experiments in rabbits. They could demonstrate boric acid in increased concentrations in the blood as well as in the urine (9). They also reported that an 8% solution of borax in water led to absorption of a fairly high percentage of the borax. Apparently the degree of absorption depends on the pH. At a pH of 9 less boric acid was observed than at a lower pH (8).

Boric acid is excreted via the kidney (3). Rost (23, 24) demonstrated that 50% of a single dose was excreted within 12 hours, but that the excretion of the other 50% took several days. Maximal excretion was observed during the 2nd and 3rd hour after application, following which the rate of excretion decreased. Accordingly, accumulation in the tissues might occur.

In our case, the occurrence of the symptoms was probably to be attributed to the unusual circumstances under which the patient worked: 1) in an inadequately ventilated store room, which once more emphasizes the importance of occupational hygiene, particularly the long period of contact with borax. In this respect, cumulation plays an essential part. 2) Probably, the nature of the compound also plays an important part in regard to absorption. It is known that soaps and detergents may alter the permeability of the skin and mucosa, so that absorption might take place very easily.

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