

Spectrophotometric Measurement of Boric Acid in a Case of Accidental Ingestion

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Abstract

We present a case of accidental boric acid ingestion. The quantification of boric acid in the patient's serum was performed by the curcumin method. The serum level of boric acid (1246.5 µg/mL) indicated the patient had ingested an almost fatal quantity of boric acid, estimated to be at least 9.4 g, and was severely poisoned. Our findings provide useful information for the treatment of boric acid poisoning.

Key words: spectrophotometric test, curcumin method, borate

INTRODUCTION

The primary aim of the clinical toxicology in a hospital is to assist in the treatment of patients (1). A sufficient level of quality is involved in estimating blood levels or quantities of ingested chemicals to make appropriate clinical decisions (1). Boric acid is an odorless white powder (2), and it has been used as an antiseptic for external use for many years (3). It is widely used as poisonous cockroach bait in Japan (4,5,6,7), and accidental poisoning cases have been reported (4,5,6,7,8) The application of a spectrophotometric test for the quantitation of ingested boric acid is reported in this paper.

CASE REPORT

Japanese woman in her eighties (height: 158 cm, weight: 44.6 kg) was admitted to the hospital due to illness. She had mild senile dementia. Subsequent investigation by her family revealed that she may have ingested a boric acid-containing dumpling intended for the elimination of cockroaches, which had been put on a table in the kitchen. Clinical findings included severe renal failure with anuria. A serum sample at the time of admission was collected by the medical doctor. The examinations for identification and quantification of boric acid were performed by forensic toxicologists because the hospital laboratory was not set up to perform toxicological examinations.

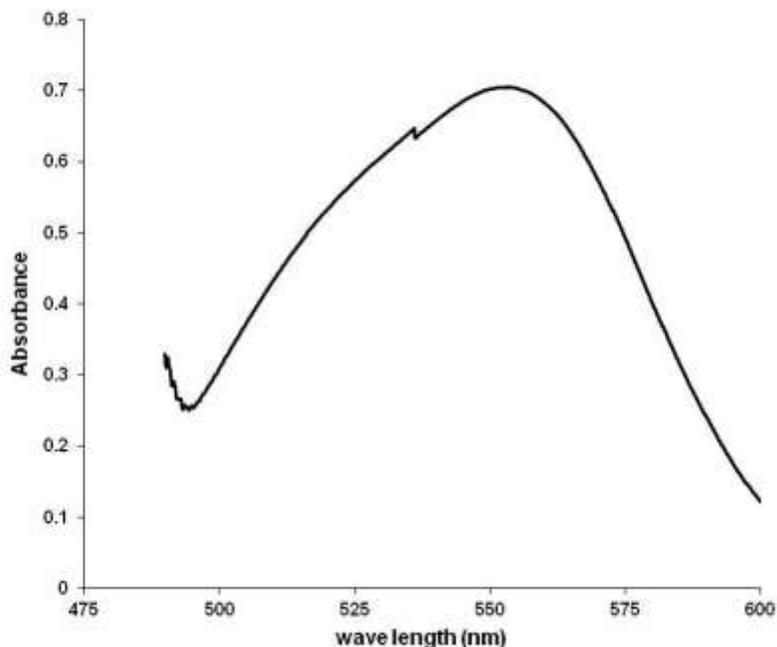
MATERIALS AND METHODS

Chemical reagents used were all analytical grade (Wako Pure Chemical Industries, Osaka, Japan). Spectrophotometric analysis for boric acid was performed as described previously (9). Briefly, 0.2 mL of 50% sulfuric acid and 4 mL of 10% 2-ethyl-1,3-hexandiol/chloroform solution was added to 1 mL of sample and shaken for 5 min. Then, the mixture was centrifuged (3000 rpm) for 10 min, and the organic layer was collected as extract. The curcumin reagent (0.5 mL, 0.3% curcumin/acetic acid) and 0.05 mL concentrated sulfuric acid were added to 0.05 mL of extract. The formation of rosocyanine, which was confirmed by absorbance observed at 550 nm, indicated the existence of boric acid in the sample by the reaction with protonated curcumin. Spectrophotometric analysis was performed using a Shimadzu UV-1280 spectrophotometer (Kyoto, Japan). Standard solutions of boric acid ranging from 10 µg/mL to 200 µg/mL were used for the preparation of a calibration curve.

RESULTS AND DISCUSSION

The absorption spectrum of the sample in the present case (Fig.1) showed a peak at 550 nm. This indicated the presence of a high concentration of boric acid. A regression line of $Y = 144.34X - 4.1651$ was obtained between the measured absorbance at 550 nm and borate concentration (µg/mL) as a calibration curve.

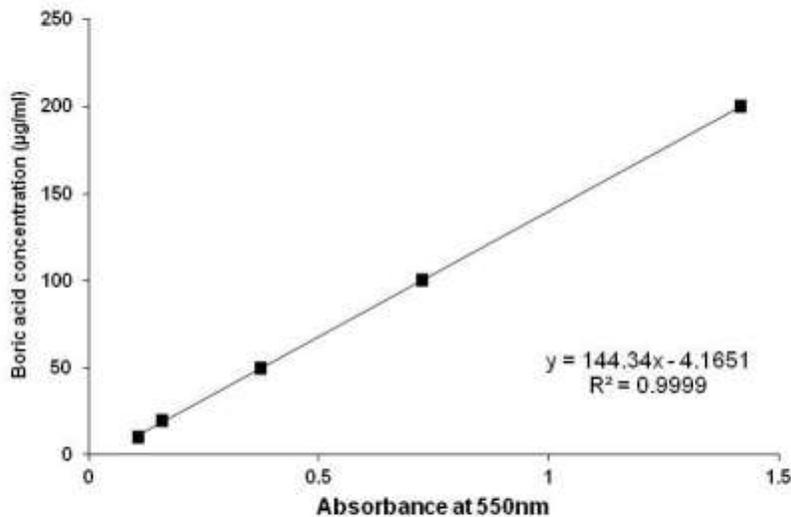
Figure 1. Absorption spectrum of the sample in the present case; it shows a peak at 550 nm.



The correlation coefficient was $r = 0.999$ (Fig.2). The quantification limit of borate was $10\mu\text{g/mL}$ in this experimental condition. The concentration of boric acid in the patient's serum was $1246.5\ \mu\text{g/mL}$ upon admission to the hospital. This result corresponded to the clinical findings.

The clinical findings and results of the toxicological examination confirmed that the patient had ingested boric acid-containing

material, which is commonly used for the elimination of cockroaches. We also estimated the patient's total amount of ingested boric acid using toxicokinetic factors was also estimated (1). It was estimated that she had ingested at least 9.4 g of boric acid (estimated range: 9.4-27.6 g) using the volume of distribution (V_d : 0.17-0.50 L/kg) [10], the patient's body weight and serum concentration.

Figure 2. Calibration curve for boric acid.

The fatal range of plasma boric acid concentration is 200-1600 µg/mL (3); however, survival has been reported in a patient with in excess of 1000 µg/mL of boric acid on admission followed by intensive medical treatments (3). The fatal dose in an adult is approximately 15-30 g (2). In the present case, the serum level of boric acid on admission to the hospital and estimated amount of intake indicated that she had severe, almost fatal, boric acid poisoning. However, as a result of intensive care and treatment, including hemodialysis, her condition improved. Spectrophotometric analysis is widely used for the quantitative measurement of pharmaceuticals in biological samples as a primary method (11). It may also be helpful in identifying chemicals involved in suspected poisoning cases (11). Since most hospital laboratories are not set up for the measurement of serum boric acid levels (2),

forensic toxicologists could provide technical support to clinicians in the treatment of poisoned patients.

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