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CASE REPORT

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# Cocaine found in a child's hair due to environmental exposure?

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**Abstract** We report a case of a 6-year-old boy who had been living with his parents, both cocaine smokers, and who was urgently admitted to hospital for general distress. Upon examination, cocaine and cocaine metabolites were detected in hair and urine samples. These toxicological findings most likely indicate that the child had passively consumed the drug when living in a heavily contaminated environment.

**Keywords** Cocaine · Drug abuse · Environmental drug exposure · Hair analysis · Forensic toxicology

## Introduction

Hair analysis is a well established procedure for investigation of chronic drug abuse. Its primary advantage is that it allows a relatively long retrospective identification of a wide number of drugs which normally quickly disappear from blood and urine [1, 2, 3, 4]. For this reason hair analysis is considered a useful tool in forensic investigations, especially when the toxicological analysis is performed weeks or months after the suspected drug exposure [5, 6].

Interpretation of the results are, however, rather controversial because of various factors that influence incorporation of drugs into the hair matrix, such as growth rate, color of hair, external contamination, and interindividual variability [7, 8, 9]. It is thus clear that the detection of a substance in hair is an indicator of exposure to that substance, but not necessarily of its voluntary use. The most controversial points are hence the possibility of environmental contamination of hair and the true ability to distinguish this environmental exposure from an active consumption [10, 11, 12, 13, 14, 15]. Children whose parents use drugs at home can be at risk of passive environmental drug exposure [12].

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## Case report

A 6-year-old child was admitted to the emergency department, because of a generalized malaise associated with mild agitation, tachycardia, arterial hypertension, and mydriasis. As the mother of the child was known to be a cocaine addict, a suspicion of cocaine intoxication was raised. The forensic toxicologist was therefore asked to assess the probable presence of cocaine in the child's urine. The prosecutor also requested that a potential previous cocaine intake be evaluated through hair analysis. For toxicological analysis, a spot urine sample was taken on arrival at the emergency department. No information on the urine creatinine concentration or an infusion therapy was available. In addition, a sample of light brown-colored hair cut near to the scalp was collected, measuring 1.5 cm and weighing about 80 mg. Blood was unavailable as a toxicological specimen because the forensic expert was involved in the case 24 h after the child's arrival at the hospital.

Information concerning the environment where the child had been living was obtained from the police report. The samples analyzed by the police included, for example, a microwave oven where the parents had prepared crack.

The hair samples were analyzed twice using the routine procedure carried out in the laboratory for toxicological hair analysis. First, a specimen of 40 mg, and, afterwards, a replicate specimen of 20 mg were used. Hair samples were decontaminated by centrifugation twice with 2 ml of methanol and these solutions were kept for subsequent analysis. After the addition of deuterated internal standards (cocaine-$D^3$ and BZE-$D^3$), the hair sample was then subjected to acidic hydrolysis by incubating for 3 h with 1 ml of 0.1 M HCl. Both the hydrolyzing medium and the washing solutions, as well as the urine sample, were then analyzed for cocaine and benzoylecgonine (BZE): the samples were alkalinized with phosphate buffer and a liquid/liquid extraction was performed by shaking with a mixture of chloroform/isopropanol (9:1) for 10 min. After centrifugation, the organic phase was evaporated to dryness under a nitrogen stream and derivatized with pentafluoropropionic anhydride in the presence of pentafluoropropanol at 70°C for 30 min. The residue was then evaporated to dryness, reconstituted in 25 µl of ethyl acetate and 1 µl of the derivatized extract was then injected into the GC/MS. Instrumental analyses were performed on a Hewlett-Packard 5890GC coupled with a Hewlett-Packard 5971A mass selective detector. The GC was equipped with a 5% phenylmethylsilicon capillary column (12 m×0.2 mm. i.d., 0.33 µm film thickness) and the GC injection port was set at 260°C in splitless mode. The oven temperature was held at 120°C for 1 min, increased to 200°C at 20°C/min, then increased to 240°C at 5°C/min, then to 280°C at 30°C/min, and held for 5 min. The mass detector was operated in electron impact at 70 eV in selected ion monitoring (SIM) mode, acquiring the following ions: cocaine: m/z 182, 198, 303, cocaine-D3: m/z 185, 201, 306, BZE: m/z 300, 316, 421, BEG-D3: m/z 303, 319, 424.

Quantitative GC/MS analysis demonstrated the presence of significant amounts of cocaine and BZE both in the child's urine and hair samples. Urinary concentrations were 109 and 145 ng/ml of cocaine and BZE, respectively. In the hair samples mean values of 16 ng/mg of cocaine and 0.6 ng/mg of BZE were detected. Cocaine was detected only in the first washing solution at a 2 ng/ml level.

In order to evaluate the possibility of passive contamination of hair, we followed the four criteria recommended by the Society of Hair Testing [16]. The cocaine metabolite, BZG, was identified in the hair sample, and the metabolite-to-parent drug ratio was evaluated (0.6:16). The threshold values adopted were 1 ng/mg and 0.5 ng/mg for cocaine and BZE, respectively.

## Discussion

The present case reports an acute cocaine intoxication with tachycardia, mild agitation, and mydriasis as the child's main medical symptoms, in which toxicological analysis of both urine and hair revealed a high level of cocaine, taking into consideration the age and body weight of the child. The high amount of cocaine with respect to BZE in the child's urine is not surprising in a spot urine specimen: we are not able to know exactly at which point of the metabolization/elimination curve the urine was sampled; furthermore the values found could be explained by a metabolic disorder due to a chronic cocaine intoxication.

The results of the hair analysis, and in particular the relationship between the amount of cocaine on the external surface of the hair and of that entrapped in the keratin matrix, demonstrates that this child had been systematically subjected to cocaine exposure, at least during the last month (the length of the hair sample was 1.5 cm).

The issue of environmental contamination of human hair with cocaine has been widely debated. Many experiments have been carried out in order to study such contamination and its removal. It is in fact possible that certain drugs, especially cocaine, can contaminate a non-user's hair, and as a general rule especially for forensic purposes, the results must be differentiated between external contamination and active assumption of the drug. Smith and Kidwell have reported a field study on cocaine contamination of hair of children of cocaine smokers. Several of these children were characterized as having hair assay values indistinguishable from their cocaine-using parents; the authors ascribed such values to be more likely due to an external contamination of hair fibers than to a possible unintentional ingestion [11]. On the contrary, Mieczkowski has found that persons (such as narcotics officers) who have chronic contact with cocaine may result positive even if at low values. Furthermore, children whose parents use drugs at home are considered to be at risk of a passive drug consumption [12]. Although Romano et al. reported that external hair contamination with cocaine powder would be indistinguishable from cocaine consumption if samples are analyzed some days after the contamination [13], a previous study by Koren et al. demonstrated that in subjects passively exposed to crack smoke, only cocaine was present in hair samples and it was completely washed out with standard decontamination procedures [14].

Nonetheless, in relation to the present case, these issues are not of paramount importance. Indeed, the presence of cocaine and BZE in the child's urine demonstrates a consumption of cocaine. To our understanding the relative high amount of cocaine in the child's hair and the presence of cocaine and metabolites in the urine can be explained by the effect of environmental exposure to the drug that led to a passive, but substantial intake. According to the literature, normal concentrations of cocaine and BZE detected in hair samples of adult drug addicts range between 0.3 and 98 ng/mg and 0.1 and 14 ng/mg, respectively [17]. The cocaine and BZE concentrations in the child's hair are therefore compatible with drug consumption. In children, in fact, detected cocaine concentrations should be compared to their body mass. As discussed by Mieczkowsky, smaller children often present relatively higher amounts of cocaine, probably due to their attitude to crawling and putting objects in their mouth and to the ratio of cocaine ingested/body mass [12].

We have no data to verify either the real amount of cocaine potentially ingested by the child in his normal life conditions by the contact with contaminated objects, or to verify the amount of cocaine assumed by the exposure to passive crack smoke, that can lead to both an external hair fiber contamination and a passive cocaine intake. Actually, as demonstrated by the presence of cocaine in the washing solution, the possibility cannot be excluded that the presence of this substance also on the external surface of hair was purely due to passive exposure.

In conclusion, we suggest that for the amount of cocaine and BZE found in the hair and urine of a 6-year-old child, an involuntary environmental exposure leading to passive consumption is likely to have occurred.

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