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Excretion of Methamphetamine in Cases of Methamphetamine-Related Death

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Abstract

Background: Methamphetamine (MA) is one of the most abused drugs, and MA abuse is a public concern in the world.

Aims: The present study compared MA excretion in urine, bile and stomach contents.

Methods: We present three cases of MA-related death.

Results: Toxicological examination revealed relatively high concentrations of MA in bile and urine. MA was also detected from stomach contents despite parenteral administration in each case.

Conclusion: Alongside urine, we should consider other postmortem samples such as bile or stomach contents as excretion routes.

Keywords: methamphetamine; abuse; alternative specimen; bile; stomach contents; urine

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INTRODUCTION

Methamphetamine (MA) is one of the most abused drugs, and MA abuse is a public concern both in Japan and worldwide (1-3). The pharmacokinetics and distribution following MA administration have been investigated in detail (4-10). As the urine is the main route of excretion, urine testing has been reported to be a suitable screening test for MA abuse (11-14). A relatively large amount of MA is reportedly excreted in bile (5, 7, 8, 15-17), but this has not received much attention. Even with parenteral administration, MA can also be identified in the stomach, which is thus attracting attention as a non-biliary route of gastrointestinal secretion (18-20).

The present study compared MA excretion in urine, bile and stomach contents in three cases of MA-related death, and the utility of these findings in daily forensic practice is discussed.

MATERIALS AND METHODS

We encountered three autopsy cases of MA-related death. Samples of urine, stomach contents, bile and peripheral blood were collected for toxicological examination. Urine samples from all three cases yielded positive reactions from immunochromatographic screening devices. The quantitation of MA concentration was performed by high-performance liquid chromatography/tandem mass spectrometry, as described previously (21). We evaluated concentrations in urine, stomach contents and bile in comparison with blood concentration.

CASE HISTORY AND AUTOPSY FINDINGS

Case 1

A male in his fifties was found dead in his house. A needle mark was observed in the left cubital fossa. Toxicological examination identified MA in all postmortem samples including stomach contents. Cerebral hemorrhage with rupture into a cerebral ventricle was confirmed at autopsy. The cause of death was concluded to be cerebral hemorrhage induced by MA use.

Case 2

A male in his forties was found dead in a pond. Autopsy revealed findings suggestive of drowning. A needle mark was observed in the left cubital fossa. The victim had told his friends about his MA use, and this circumstantial evidence was supported by the results of the toxicological examinations. The diatom test was positive. We concluded that the cause of death was drowning under the influence of MA.

Case 3

A male driver in his forties was found dead on the roadside. An injection scar was noted on the arm. MA use was confirmed by the toxicological examinations including stomach contents. Autopsy revealed skull fracture with traumatic subarachnoid hemorrhage (SAH) and brain contusion. The cause of death was concluded to be traumatic SAH under the influence of MA.

RESULTS AND DISCUSSION

MA was detected in all three cases. Table 1 shows the concentrations of MA in postmortem samples. All three cases were concluded to have involved intravenous administration, based on autopsy findings and subsequent investigations by the authorities.

MA concentrations in urine were markedly higher (5.2–73.9 times) than those in the blood (Table 2). The pharmacokinetics of MA have been investigated in detail (4, 5, 7, 10). Since a large proportion is excreted in urine soon after ingestion, urine samples are widely used to test for evidence of drug use (12, 13). This sample is relatively easy to collect, and so is widely used for screening tests, and immunochromatography kits are also commercially available (22). As urinary excretion depends on urinary pH (14, 23), concentrations in urine are not always reliable for estimations of blood concentrations (12). Our results support the utility of urine samples in screening for MA use.

A relatively high concentration of MA was observed in stomach contents in all three cases. Some types of basic drugs such as meperidine, midazolam and diltiazem are excreted via stomach following intravenous administration (24, 25). MA is a basic drug, and thus this is secreted into the stomach following intravenous administration (17-20). The stomach is attracting attention as a key route of non-biliary gastrointestinal secretion. A stomach-to-blood

Table 1. Concentration of methamphetamine (MA) in each post-mortem sample (μg/mL)

Case No	age	peripheral blood	urine	stomach contents	bile
1	50 s	1.3	6.7	19.0	4.9
2	40 s	2.4	164.0	3.5	9.8
3	40 s	0.7	51.7	4.1	18.4

Table 2. Cause of death and postmortem sample/blood ratio in each case

Case No	cause of death	urine/blood	stomach contents/blood	bile/blood
1	cerebral hemorrhage induced by MA	5.2	14.6	3.8
2	drowning under influence of MA	68.3	1.5	4.1
3	traumatic SAH under influence of MA	73.9	5.9	26.3

ratio of MA concentrations ≥36 is reportedly consistent with oral ingestion of MA (18). In the present study, stomach-to-blood MA ratios were 1.5–14.6 (less than 36 in each case), and injection scars with hemorrhage were confirmed. We therefore concluded that none of the three cases involved oral administration of MA.

Bile is one of the pathways of elimination for xenobiotics (26-28), and MA is known to accumulate in bile following administration (5, 7-9, 15-17). Concentrations of MA in bile are several times higher than those in postmortem blood (8, 9, 16, 17). Similar tendencies for MA concentrations in bile were observed in each of the present cases (Table 2). Bile concentrations reportedly increase within a short time, then decrease in a linear manner following a single administration of MA in animal experiments (5, 7). Bile is thus a useful sample for confirming the intake for autopsy cases in which blood or urine samples are difficult to collect. In the present cases, bile-to-blood ratios of MA concentrations fell within broad ranges of 3.8–26.3 (Table 2). Although bile may offer a useful indicator of MA use, as with urine, MA concentrations in bile may not be as useful for estimating blood concentrations. Bile samples could be recommended for use in a complementary matrix for MA screening (17, 26-28).

CONCLUSION

The results of this study indicate that excretion into the stomach contents and bile may be used as alternative samples when blood cannot be collected in daily forensic practice. The cases examined here were not cases of death directly by MA poisoning, but instead represented cases with relatively low MA concentrations. However, the same principles apply as in cases of death by poisoning, and when MA use is suspected, collection of these samples may be practical and useful.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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Ethical approval

The use of the samples collected on autopsy and report on this autopsy case were approved by the Research Ethics Committee of Kagawa University Faculty of Medicine.

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