

## CASE REPORT

*Einosuke Tanaka,<sup>1</sup> Ph.D.; Katsuya Honda,<sup>1</sup> M.D.; Hisashi Horiguchi,<sup>1</sup> M.D.; and Shogo Misawa,<sup>1</sup> M.D., Ph.D.*

### Postmortem Determination of the Biological Distribution of Formic Acid in Methanol Intoxication

---

**REFERENCE:** Tanaka, E., Honda, K., Horiguchi, H., and Misawa, S., "Postmortem Determination of the Biological Distribution of Formic Acid in Methanol Intoxication," *Journal of Forensic Sciences*, JFSCA, Vol. 36, No. 3, May 1991, pp. 936-938.

**ABSTRACT:** Two 25-year-old men were fatally intoxicated with methanol. The formic acid levels in their blood, urine, and organs were determined postmortem by headspace gas chromatography. The postmortem concentrations of formic acid in the two patients were the following: 0.32 and 0.23 mg/mL in blood, 2.27 and 0.47 mg/mL in urine, 0.11 and 1.17 mg/g in the brain, 0.54 and 0.51 mg/g in the liver, and 0.13 and 1.19 mg/g in the kidneys. The total amounts of formic acid in the gastric contents were 108 and 23.2 mg.

**KEYWORDS:** toxicology, methanol, chromatographic analysis, gas chromatography, formic acid, biological distribution

Methanol is commonly used as a solvent in various coatings such as house paint and in other materials such as dyes, fuels, and antifreezes. Methanol is metabolized in vivo to produce acetaldehyde and formic acid, and it has recently been reported that methanol toxicity is to be attributed to formic acid rather than to acetaldehyde [1,2]. For that reason, measurement of blood formic acid concentrations was essential in assessing methanol poisoning. However, there have been only a few reports on the determination of formic acid levels resulting from methanol intoxication [3-5].

In the present study, the authors performed postmortem determination of formic acid levels in the blood, urine, and body tissues of two patients who died from methanol intoxication.

#### Case History

Two 25-year-old men drank fuel methanol by mistake. After 10 h they complained of poor appetite and lumbago, and after 18 h they had severe stomachache. After 21 h they

Received for publication 25 June 1990; revised manuscript received 31 Aug. 1990; accepted for publication 5 Sept. 1990.

<sup>1</sup>Assistant professor, lecturers, and professor, respectively, Department of Legal Medicine, Institute of Community Medicine, University of Tsukuba, Tsukuba, Japan.

TABLE 1—*Postmortem distribution of formic acid.*

Specimen	Case 1	Case 2
Blood, mg/mL <sup>a</sup>	0.32	0.23
Urine, mg/mL	2.27	0.47
Brain, mg/g	0.11	1.17
Liver, mg/g	0.54	0.51
Kidney, mg/g	0.13	1.19
Gastric contents (total), mg	108	23.2

<sup>a</sup>Heart blood.

became nauseated and confused and then entered the hospital, where they both expired 1 h later. The exact amount of methanol ingested was unknown.

### Methods

The concentration of formic acid in the blood, urine, and body tissues was performed by a method previously published [6]. The gas chromatograph used was a Hitachi Model GC-163, equipped with a flame ionization detector. The glass column (2 m by 3 mm in inside diameter) was packed with Porapak Q (80 to 100 mesh). The injection port and detector temperatures were 200 and 135°C, respectively.

### Results and Discussion

The distribution of formic acid after lethal methanol intoxication is summarized in Table 1. In Case 1 the highest formic acid concentration was found in the urine, and in Case 2 the highest level was in the kidney and brain. Previous reports concerning formic acid measurement have, for the most part, been confined to blood concentrations. The reported concentrations include 0.31 mg/mL, by Shahangian et al. [4]; <2.5 to 104 mg/mL, by Fraser and MacNeil [3]; and 0.015 to 0.19 mg/mL by Mahieu et al. [5]. Mahieu et al. [5] also reported that blood formic acid concentrations above 0.5 mg/mL lead to severe methanol poisoning. The blood concentrations in our patients, however, were less than those reported above. The same is true of the methanol concentrations. The discrepancies among these reports in the blood concentrations of methanol and formic acid may be attributable to such factors as the amount of methanol ingested, the time of blood collection, individual variation, and the presence or absence of medical treatment for intoxication, all of which vary from case to case. Consequently, it is extremely difficult to determine the lethal doses of methanol and formic acid in humans. Meanwhile, the symptoms of our two intoxicated patients were similar to those reported previously [5, 7].

### References

- [1] Martin-Amat, G., McMartin, K. E., Hayreh, M. S., and Tephly, T. R., "Methanol Poisoning: Ocular Toxicity Produced by Formate," *Toxicology and Applied Pharmacology*, Vol. 45, 1978, pp. 201–205.
- [2] McMartin, K. E., Makar, A. B., Martin-Amat, G., Palese, M., and Tephly, T. R., "Methanol Poisoning: 1. The Role of Formic Acid in the Development of Metabolic Acidosis in the Monkey and the Reversal by 4-Methylpyrazole," *Biochemical Medicine*, Vol. 13, 1975, pp. 319–333.
- [3] Fraser, A. D. and MacNeil, W., "Gas Chromatographic Analysis of Methyl Formate and Its Application in Methanol Poisoning Cases," *Journal of Analytical Toxicology*, Vol. 13, 1989, pp. 73–76.
- [4] Shahangian, S., Robinson, V. L., and Jennison, T. A., "Formate Concentrations in a Case of Methanol Ingestion," *Clinical Chemistry*, Vol. 30, 1984, pp. 1413–1414.

- [5] Mahieu, P., Hassoun, A., and Lauwerys, R., "Predictors of Methanol Intoxication with Unfavourable Outcome," *Human Toxicology*, Vol. 8, 1989, pp. 135-137.
- [6] Kuo, T.-L., "The Effects of Ethanol on Methanol Intoxication: I. A Simple Headspace Gas Chromatography for the Determination of Blood Formic Acid," *The Japanese Journal of Legal Medicine*, Vol. 36, 1982, pp. 669-675.
- [7] Ellenhorn, M. J. and Barceloux, D. G., *Medical Toxicology*, Elsevier, New York, 1988.

Address requests for reprints or additional information to

Dr. Einosuke Tanaka  
Institute of Community Medicine  
University of Tsukuba  
Tsukuba-shi, Ibaraki-ken 305  
Japan