



## Toxicological results in a fatal and two non-fatal cases of scopolamine-facilitated robberies



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### ABSTRACT

The use of scopolamine as an incapacitating drug, in sexual crimes and robberies, has been known for many decades. However, blood concentrations and doses of scopolamine in those cases are largely unknown. Here we present the toxicological results of one fatal and two non-fatal cases in a series of scopolamine-facilitated robberies. In the fatal case, the concentration of scopolamine in heart blood was 0.30 mg/L, about 3000 times higher than the average therapeutic level of 0.0001 mg/L (for one dermal patch). In femoral blood, the concentration of scopolamine was much lower (0.0048 mg/L), but still 50 times higher than therapeutic levels. The scopolamine concentration in the stomach was very high (20 mg/kg) as compared to the heart blood and femoral blood, which explains the very high concentration in heart blood by postmortem leakage from the stomach. In the non-fatal case, the scopolamine concentration in serum, obtained 23 h after the incident, was 0.00035 mg/L. The estimated concentration of scopolamine at the time of the incident is 0.0035 mg/L. In the other non-fatal case, scopolamine was detected in urine and in hair.

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### 1. Introduction

Scopolamine, also known as hyoscine, is an anticholinergic drug that is used worldwide for treating motion sickness. The most popular generic form is a dermal patch, which contains 1.5 mg of scopolamine. The scopolamine is delivered through the skin at a rate of about 1 mg per 3 days; this leads to a low steady-state plasma concentration of 0.00005–0.00010 mg/L [1]. Scopolamine is also used by a limited number of illicit drug users, generally for its hallucinogenic properties, but also for its presumed aphrodisiac properties [2; 3; 4; internet reports of users]. Vallersnes et al. [5] described an epidemic of scopolamine poisonings among illicit drug users by ingestion of “fake” Rohypnol tablets containing scopolamine. Main clinical features were mydriasis, (visual) hallucinations, plucking behavior, agitation and coma.

The use of scopolamine as an incapacitating drug, in sexual crimes and robberies, has been known for many decades. Extracts of Brugmansia and Datura plants have been reported to be widely used for that purpose in South-America [6]. Anterograde amnesia, hallucinations and submissive behavior are prominent symptoms in victims of scopolamine-facilitated crimes [7]. In contrast to its

possibly widespread use in drug-facilitated crimes, blood concentrations and doses of scopolamine in those cases are largely unknown.

Recently, LeGarff et al. [8] described a fatal case of a fatal Datura poisoning during a robbery. The victim's death was attributed to disordered heart rhythm due to severe anticholinergic syndrome. Blood concentrations of scopolamine, atropine and hyoscyamine could unfortunately not be measured as the corpse was embalmed.

In this article, we present one fatal and two non-fatal cases of scopolamine-facilitated robberies.

In the fatal case and in one non-fatal case, blood concentrations were measured.

### 2. Description of the cases

#### 2.1. Case 1

A 53-year old man was found dead at home, lying in his bed in prone position. There were no signs of a crime and natural death was concluded. In the next days, cash withdrawals from the deceased's bank account took place by the use of his debit card. Several other cases of possible drug-facilitated robbery, involving the same suspect, were brought to the attention of the police. This led to a forensic autopsy of victim 1, about 3 days after the discovery of the body, which was probably 4–5 days after his death.

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Investigations by the police showed that the suspect dated other men, intoxicated and robbed them. Analysis of the suspect's computer showed that he had searched the internet for scopolamine.

### 2.2. Case 2

Victim 2 met the suspect in a cafe. They had dinner in a restaurant and then went to the victim's home to drink whiskey. After drinking the whiskey, the victim only remembers that he was scaring off non-existent visitors. Later, he interpreted this as hallucinations. He also noticed that several of his belongings were stolen. He went to a hospital for a urine analysis on his own account (approximately 12 h after the incident). This analysis indicated the presence of opiates in his urine, which proved to him that he had been intoxicated and that he had to contact the police. A hair sample was taken by the police, 79 days (2.6 month) after the incident.

### 2.3. Case 3

Victim 3 got into contact with the suspect via a gay dating site. On the day of the crime, the suspect came to the victim's home to prepare dinner, of which some components tasted bitter. During the after-dinner massage, the victim lost consciousness and remained unconscious for 15 h. After waking up, he noticed that several goods had been stolen. As he suffered of nausea and amnesia, he went to the hospital on his own account, where a serum and a urine sample were taken, 22 h after the massage. As the toxicological analysis in the hospital gave negative results, he went to the police.

## 3. Materials and methods

Postmortem investigations (autopsy, toxicological, histological and immunohistochemical examinations) were performed according to medicolegal standards, using protocolized and audited procedures. The toxicological analysis was performed as described previously [9], and consisted of an alcohol analysis with GC–FID, using two columns with different polarities, a GHB analysis with GC–MS after BSTFA-derivatization, a targeted analysis of 57 compounds with LC–MS/MS, and a general unknown screening that consisted of HPLC–DAD analysis and GC–MS analysis after BSTFA-derivatization. The concentrations of scopolamine and citalopram were determined by targeted LC–MS/MS analysis, using the same instrumentation and a similar method as described previously [9]. Hair analysis was performed on four successive 1-cm hair segments by Laboratoire ChemTox, France, using LC–MS/MS.

## 4. Results and discussion

### 4.1. Case 1

Histopathological examinations showed moderate postmortem changes, in agreement with a post-mortem delay of several days. There were no signs of a pathological disorder that could explain death. Edema was present in the brain and lungs and there was urine retention. In the small airways, stomach content was found. This may have been a possible cause of death, by induction of asphyxia. However, literature shows that stomach content may also reach small airways by manipulation of the body after death [10]. The prone position in bed is also likely to have caused asphyxia (positional asphyxia). There were no signs of violence, except for a hemorrhage under the lip. Wound dating showed that this lesion was acquired 3–5 h before death; it may have been caused by accident, e.g. bumping.

The systematic toxicological analysis showed the presence of scopolamine and citalopram in heart blood. The concentrations of scopolamine and citalopram were then measured in both heart blood and femoral blood, in order to study possible postmortem redistribution. There were no indications for the recent use of alcohol or GHB. The concentrations of scopolamine and citalopram were determined by targeted LC–MS/MS analysis and are shown in Table 1. Limits of quantitation were 0.0005 mg/L for scopolamine and 0.001 mg/L for citalopram.

The concentration of scopolamine in the heart blood (0.30 mg/L) was about 3000 times higher than the average therapeutic level of 0.0001 mg/L (dermal patch). In femoral blood, the concentration of scopolamine (0.0048 mg/L) was considerably lower than in heart blood, but still 50 times higher than therapeutic levels. Reference values for scopolamine in cases of intoxication are scarce. Balíková [11] reported an average serum concentration of scopolamine of 0.0130 mg/L (maximum: 0.0500 mg/L) in 12 patients who were hospitalized after drinking herbal tea that contained 78 mg of scopolamine (and/including other alkaloids) during a meditation session. Clinical features observed were: impaired perception, hallucinations, aggression, agitation, amnesia, mydriasis, dry skin, tachycardia, hyperthermia, hypotension, collapse, coma and respiratory depression. Anticholinergic symptoms have been described by others at lower concentrations (0.0005–0.0018 mg/L) [5,12] and included mydriasis, visual hallucinations, plucking behavior, agitation, altered mental status, tachycardia, facial flushing, dilated pupils, dry skin and coma. Individual sensitivity may play a role in the toxicity of anticholinergic drugs; it is known that elderly people are more sensitive to anticholinergic drugs [13]. The concentration of scopolamine in femoral blood in this case is therefore a concentration that probably will have caused some of the side-effects mentioned above.

**Table 1**

Toxicological findings in the three cases. No other compounds were detected.

Case number	$\Delta t$ (time lapse to sampling)	Material	Result
1	Unknown (fatal)	Heart blood Femoral blood Stomach contents	Scopolamine 0.30 mg/L; citalopram 0.47 mg/L Scopolamine 0.0048 mg/L; citalopram 0.66 mg/L Scopolamine 20 mg/kg
2	12 h	Urine	Ethanol 0.8 g/L; scopolamine, amphetamine, morphine, codeine, paracetamol and paracetamol-metabolites detected
3	79 days (2.6 month) 23 h	Hair Serum Urine	Scopolamine in three 1 cm-segments, 0.2–0.8 ng/mg Scopolamine 0.00035 mg/L Scopolamine, possible scopolamine-metabolites detected
	Corrected for $t_{1/2}$	Serum	Scopolamine 0.0035 mg/L

In the femoral blood of the deceased, the SSRI antidepressant citalopram was present in a concentration of 0.66 mg/L. Differentiation between citalopram and escitalopram (*S*-citalopram) was not performed, because it was known that the deceased used citalopram by prescription. Therapeutic concentrations of citalopram are generally lower than 0.3 mg/L. Toxicity may occur at concentrations greater than 0.5 mg/L and may lead to tachycardia, QT prolongation, stupor and coma. Citalopram concentrations in fatal cases reported in the literature are however generally much higher than 0.5 mg/L. The relatively high concentration of citalopram in this case may have been caused by a reduced metabolism (CYP2C19-polymorphism [14]), but this was not tested. We consider the measured concentration of citalopram in the femoral blood as supra-therapeutic and possibly toxic. This may have given rise to heart arrhythmia and low blood pressure.

In The Netherlands, the pathologist includes the toxicological conclusions from the toxicological report into the pathologist's final report. The conclusion pertaining to the cause of death is formulated in dialogue with the toxicologist. The reports of pathology toxicology report are then sent to the Court together. The pathologist concluded in this case that the most probable explanation for the death of this man was positional and/or aspirational asphyxia, caused by loss of reflexes resulting from a state of deep sleep or coma, induced by scopolamine. This scenario was however not considered as unequivocal by the Court. The suspect was sentenced for 11 cases of robbery, of which 3 with violence (i.e. the administration of scopolamine, in the three cases described here).

#### 4.2. Case 2

In the urine sample of victim 2, we detected scopolamine, codeine, morphine, paracetamol and traces of amphetamine, as well as alcohol (ethanol). The presence of morphine and codeine explains the positive result for opiates in the urine from the hospital. However, that result was unrelated to the intoxication, because the victim used paracetamol/codeine tablets, which will lead to the presence of codeine and morphine in the urine.

In the hair of victim 2, scopolamine was detected in the three successive 1-cm segments adjacent to the skin. The highest concentrations were found in the 1–2 cm (0.82 ng/mg) and the 2–3 cm (0.37 ng/mg) segments. The presence of scopolamine in the 0–1 cm hair segment (0.21 ng/mg) may be caused by delayed delivery of scopolamine from the skin, by sweat and sebum. It is well-known that incorporation of drugs or metabolites from sweat or sebum leads to an extension of the drug zone in the distal direction [15]. In the 3–4 cm segment, scopolamine was not detected.

#### 4.3. Case 3

In both the serum and the urine of victim 3, scopolamine was detected. In the urine, possible metabolites of scopolamine were detected with GC–MS. These compounds were not identified with certainty, because reference substances were not included. The scopolamine concentration in the serum sample, obtained about 23 h after dinner (time as recalled by the victim), was 0.00035 mg/L. This may be converted to a concentration of about 0.0035 mg/L at the time just after dinner, by using a half-life of scopolamine in blood of 6–7 h. If the scopolamine had been administered in the food or drink during dinner, this time point may be considered as the time of administration. The value of 0.0035 mg/L is not far from the concentration in the femoral blood of victim 1 (0.0048 mg/L). As discussed under case one, this blood concentration may have caused various anticholinergic side-effects. It should be noted that

concentrations in whole blood and serum may not be comparable; the blood/serum ratio of scopolamine is unknown.

### 5. Postmortem redistribution (case 1)

The ratio of the concentrations of scopolamine in heart blood and femoral blood (HB/FB ratio) in case 1 is greater than unity, which indicates postmortem redistribution. Because of the extremely high ratio (60) in this case, we also determined the scopolamine concentration in the stomach contents. The measured concentration was very high (20 mg/kg) compared to the measured concentrations in heart blood and femoral blood. This concentration corresponds to an amount of about 7 mg scopolamine in the stomach of the deceased. In view of the long postmortem period with concomitant changes, the high concentration in heart blood is primarily explained by postmortem leakage from the stomach, rather than release of scopolamine from (heart) tissue.

Concerning the dose and the way of administration, the suspect declared that he bought pure scopolamine via the internet. He also declared that he presented scopolamine as an aphrodisiac, and that it was ingested voluntarily by the victims, by licking a small heap of pure substance off the hand. The victims however denied this and reported a bitter taste of food and drinks. The amount of about 7 mg scopolamine that was found in the stomach of victim 1 represents a part of the ingested dose and may be compared with literature data. Low fatal oral doses of 0.4 mg and 1 mg were cited by Sticht et al. [16]. Higher fatal doses were reported by Sticht et al. (at least 13 mg) [16], in the Dr. Crippen case (34 mg, about 0.5 grain) [17], and cited by Sticht et al. (300 and 500 mg) [16]. On the other hand, non-fatal, toxic doses of 78 mg (Balíková [11]) and 435 mg (Smith et al. [18]) have been published as well. The latter value however seems very high;  $\mu\text{g}$  (microgram) units may have been substituted by mg (milligram) units in this publication, as can be seen in Table 1 [18]. The estimated dose in this case (at least 7 mg, possibly several tens of milligrams) is a dose that probably will have caused various anticholinergic side-effects.

### 6. Concluding remarks

Several tens of cases involving this suspect were brought to the attention of the police, but toxicological analysis was only performed in the three cases described here. In drug-facilitated crimes, toxicological samples are often obtained at a moment that the drugs are no longer detectable in blood or urine [19]. In the cases 2 and 3, the victims went to the hospital in time.

Scopolamine cannot be detected in blood by our systematic toxicological analysis at therapeutic blood levels. The discovery of scopolamine in heart blood with the general unknown screening appears to have been accidental, because of the high postmortem redistribution in this case.

### 7. Conclusions

In summary, this case report shows that:

- a concentration of scopolamine in blood around 0.004 mg/L corresponds to a dose that may induce deep sleep or coma in persons that are sensitive to the effects of scopolamine;
- general unknown screening should be non-targeted in order to detect unexpected drugs;
- stomach content is a useful matrix for screening;
- obtaining the right samples for toxicology may be a problem in drug-facilitated crimes;
- computers, cell phones etc of suspects may contain valuable information for the toxicologist.

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