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Fatal Methamphetamine Poisoning: Forensic Case Presentation

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Abstract

Background The rising number of methamphetamine abusers and the consequent fatalities prompted this case presentation, aiming to highlight the risks associated with its use and to enhance awareness of its detrimental effects on the human body.

Case presentation The study examined a 30-year-old male who was discovered deceased at his home in the early morning. The autopsy showed no evidence of external or internal trauma and significant gross pathological alterations. A small torn nylon package was found in the stomach's lumen, its contents released. Toxicological tests of the stomach contents, blood, and urine identified methamphetamine in the package. Laboratory results indicated a lethal concentration. The liver tissue exhibited sinusoidal cholestasis, and the kidneys displayed severe acute renal tubular necrosis.

Conclusion The study highlights the toxic and irreversible impact of methamphetamine on different human organs and the lethal consequences of smuggling the substance through oral ingestion.

Keywords Amphetamine, methamphetamine, autopsy, tubular necrosis, sudden death

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List of abbreviations: ADHD = Attention deficit hyperactivity disorder, AU = Automated, CNS = Central nervous system, FDA = Food and drug administration, GC-MS = Gas chromatography mass spectrometry, TLC = Thin layer chromatography, UVL = Ultraviolet light

Introduction

Amphetamines are central nervous system stimulants. Amphetamine, a legally food and drug administration (FDA)-approved drug, is used to treat attention deficit hyperactivity disorder (ADHD), narcolepsy, and other conditions. In contrast, methamphetamine, a more potent stimulant, is illegally produced and not FDA-approved, often found as a powder for smoking or injection for recreational use [(1)]. Methamphetamine, a synthetic and illegal psychostimulant, can cause severe neuropsychiatric disorders like paranoia, hallucinations, and even death with long-term abuse, an estimated 35 million people globally abuse it [(2,3)]. Its misuse is linked to numerous cases of sexual violence and rape [(4)]. Studies indicate that 50% of patients with acute methamphetamine intoxication in emergency departments were attempting suicide [(5)].

The drug's long-term abuse can severely damage organs, leading to conditions like rhabdomyolysis, necrotizing vasculopathy, kidney damage, and malignant hypertension [(6,7)]. Postmortem examinations of methamphetamine abusers have reported bilateral subarachnoid hemorrhages [(8)]. Additionally, its abuse has been associated with sudden death due to structural heart changes and heart failure [(9)].

The highest concentrations of methamphetamine are found in the liver, leading to intracellular damage from inflammation, chronic hepatitis, and fibrosis development [10,11]. Deaths have also been attributed to acute pancreatitis caused by methamphetamine-induced vasoconstriction and vascular thrombosis, which lead to pancreatic ischemia [12]. Chronic abuse of methamphetamine can lead to severe pathological conditions, including coronary artery disease, myocardial infarction, pulmonary hypertension, cardiomyopathy, and aortic dissection, all of which can be fatal [13]. The lethal dose of methamphetamine is 200 mg [14].

Case presentation

A 30-year-old male residing in Dewanya city was found unresponsive by his family at his home early in the morning. They quickly took him to the nearest hospital, where the emergency department doctor declared him deceased. The police then moved his body to the forensic unit for a legal medical examination. The family stated he had no known medical or surgical history and was in good health prior to his death.

During the autopsy, the forensic pathologist found no external trauma or significant internal pathological changes. Post-autopsy, samples of his body fluids and organs were preserved and sent to the main Medico-Legal Institute in Baghdad for further histopathological and toxicological analysis, as such facilities are not available in Dewanya. The samples collected included blood, urine, and tissues from the stomach, kidney, and liver. Upon opening the stomach along the greater curvature, a small transparent nylon package was discovered inside. The stomach appeared congested and contained a dirty, blood-stained, viscous fluid. The nylon package, weighing 1.64 grams, had a perforation on one side, releasing its contents into the gastric cavity, as depicted in figure (1).

Figure 1. Stomach showing congested wall containing a small transparent nylon package

The package was opened in a separate dish and its content was examined by direct color test using marquis reagent for suspecting illicit substances. Examination revealed a positive orange to brown color test for methamphetamine. The test was confirmed using the thin layer chromatography (TLC) method and a control sample. Direct extraction was done later on the stomach and its wall and the extract was injected into Gas chromatography mass spectrometry (GC-MS). The result was also positive for methamphetamine as seen in figure (2).

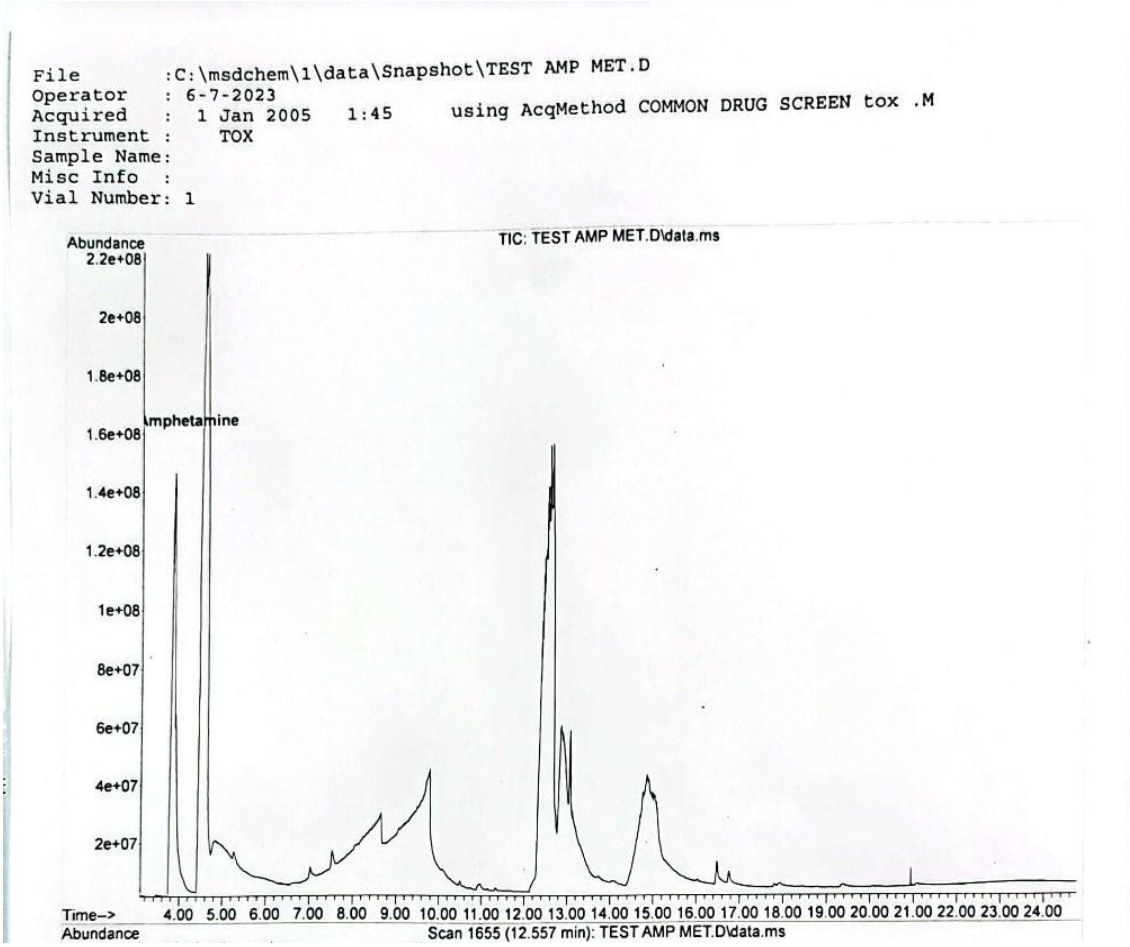

Figure 2. Methamphetamine in GC-MS graph

The Stas-Otto method, commonly used in forensic practice to detect and quantify alkaloids in biological samples, was employed to measure their concentration in the liver. This method involves maceration, ethanol mixing and filtration, tartaric acid addition, another filtration, and then heating the filtrate in a water bath. The concentrated filtrate underwent ultra violet (UV) absorption examination. The concentration was found to be 62.57 µg/g, which is considered lethal [15]. Blood and urine samples were analyzed in a biochemical laboratory using the Randox Evidence MultiSTAT Immunoanalyser (Drugs of Abuse - Toxplex Blood Array). This method allows for the semi-quantitative determination of drugs' parent molecules and metabolites in human blood, relying on competitive enzyme immunoassays conducted on the automated biochip array analyzer, Evidence MultiSTAT [16]. The findings are presented in table (1) and table (2).

Table 1. Amphetamine and methamphetamine concentrations in blood samples

Analyte	Concentration	Cutoff	Units	Result
AMP	364	20.00	ng/ml	Positive
MAMP	25.62	20.00	ng/ml	Positive

AMP: Amphetamine, MAMP: Methamphetamine

Table 2. Amphetamine and methamphetamine concentrations in urine samples

Analyte	Concentration	Cutoff	Units	Result
AMP	3466.82	500.00	ng/ml	Positive
MAMP	>3305.51	500.00	ng/ml	Positive

AMP: Amphetamine, MAMP: Methamphetamine

The quantitative analysis of creatinine in serum was performed using the kinetic Jaffe method on the Beckman Coulter automated (AU) analyzer, revealing a concentration of 301 mmol/L (Normal Value: 59-104) [17]. Liver and kidney tissue samples were subjected to histopathological examination following fixation in 10% formalin and paraffin embedding. Microscopic evaluation of the liver revealed sinusoidal congestion and intracellular cholestasis, as depicted in figure (3). In contrast, the renal tissue exhibited acute tubular necrosis in over 90% of the tubules, with proteinaceous casts occupying the lumens of the surviving tubules, as illustrated in figure (4).

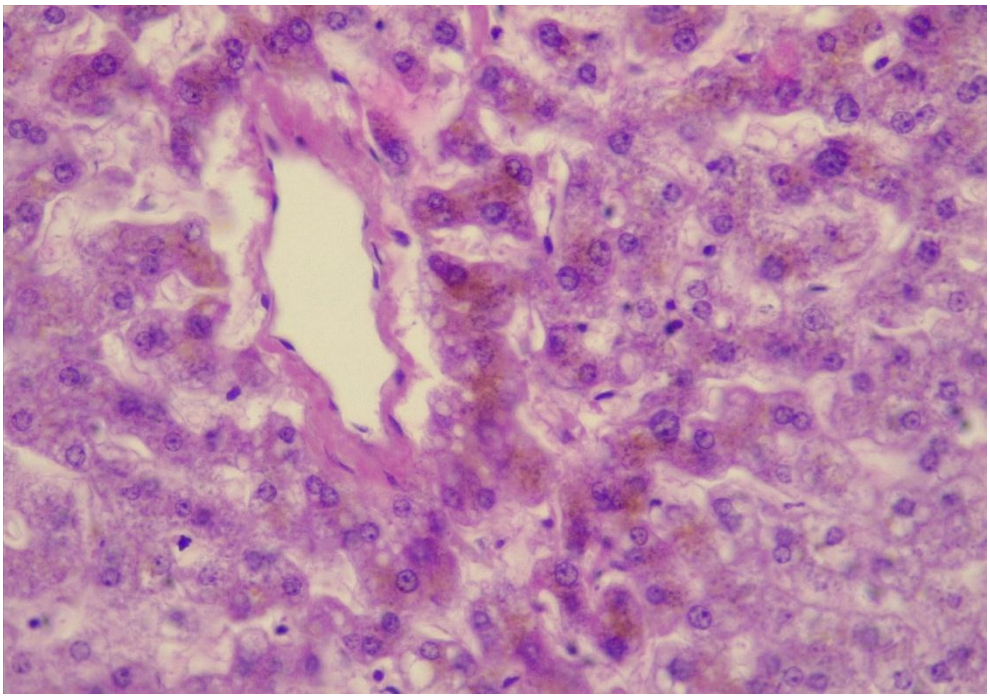

Figure 3. Hematoxilin and Eosin-stained section of the liver showing intracellular cholestasis (100X)

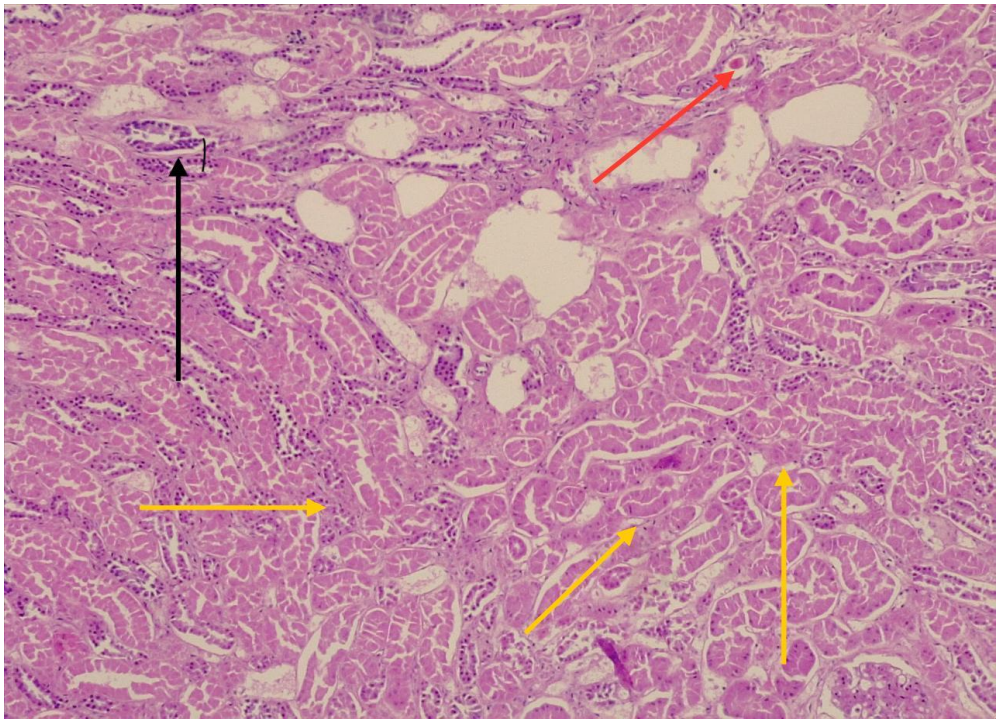

Figure 4. Hematoxilin and Eosin-stained section of the kidney shows extensive acute tubular necrosis (yellow arrows), the remaining viable tubules show epithelial degeneration (black arrow) and focal luminal proteinaceous cast (red arrow). (10X)

Discussion

Methamphetamine, a type of amphetamine, is a highly addictive and toxic substance of abuse. It exerts numerous toxic effects on various organs, such as the brain, lungs, kidneys, and liver [18].

Despite scant details surrounding the victim's death, it appears more likely to have been accidental, given that the drug was stored in a nylon package intended for smuggling, not for suicide. The leakage of the substance into the gastric lumen was probably due to a botched smuggling attempt and ignorance of the risks, resulting in the rupture of the inadequately sealed and damaged package. Chemical analysis identified the substances as methamphetamine and its metabolite, amphetamine, both present in high and lethal concentrations.

The sudden and unexpected death of the individual was likely caused by the direct cardiotoxic effects of methamphetamine on the heart. This led to a rapid increase in blood pressure due to the high release of catecholamines into the bloodstream, resulting in tachycardia, followed by cardiac arrhythmia and ultimately, sudden death [19,20]. This explanation goes with the finding of previous study which reported that cardiovascular complications are the most common causes of death especially in older adults [21]. In another study extreme hyperthermia that resulted from a lethal dose of methamphetamine causing the release of monoamines and inhibit their uptake centrally and peripherally can be life threatening and may cause death [22].

Histopathological examination of the liver revealed intracellular cholestasis, often a consequence of the toxic effects of certain drugs and chemicals, with methamphetamine being one such substance [23]. Additionally, methamphetamine's harmful impact on the kidneys is due to its increased reabsorption, leading to greater accumulation and consequently, elevated levels of urinary excretion [24].

In this instance, there was significant acute renal tubular necrosis, affecting over 90% of the tubules. The remaining viable tubular lumens

contained proteinaceous casts, likely myoglobin, due to rhabdomyolysis from skeletal muscle damage, leading to deposits in the renal tubules and resulting in acute renal failure [6, 7, 25]. Regrettably, a special stain to confirm the cast type was unavailable. Additionally, another microscopic observation in the victim's kidney was complete ischemic necrosis of the blood vessels accompanied by necrotizing vasculopathy [6,7,23,26]. These severe histopathological alterations corresponded with elevated serum creatinine levels, which are recognized as the most stable biochemical postmortem parameter [27].

In summary, this study highlights the harmful and toxic effects of methamphetamine on various human body organs, with a lethal outcome, particularly when a high dose is ingested orally.

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Author contribution

Sami: did body fluids and tissue extractions followed by drug identification and concentrations determination. Dr. Al-Qazzaz: did histopathological examination of the liver and kidney and interpretation of the results and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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