



CASE REPORT

Methamphetamine Overdose with Acute Kidney Injury and Rhabdomyolysis

Nurul Huda Abdullah^{1*}, Nurizat Muhammad¹, Abdul Hanan Abdullah¹, Mohamad Najmi Ahmad², Wan Hasnul Halimi Wan Hassan³



¹Clinical Lecturer and Internal Medicine Physician, Internal Medicine Department, Universiti Sains Malaysia (USM), Kelantan, Malaysia

²Medical Officer (Nephrology Unit), Internal Medicine Department, Universiti Sains Malaysia (USM), Kelantan, Malaysia

³Consultant Nephrologist, Nephrology Department, Hospital Raja Perempuan Zainab 2, Kelantan, Malaysia

*Corresponding author: Nurul Huda Abdullah, Medical Lecturer and General Physician, Internal Medicine Department, Universiti Sains Malaysia, Health Campus, 16150 Kubang Kerian, Kelantan, Malaysia, Tel: +60-1126917004; +609-7676590

Abstract

Methamphetamine is an easily available drug worldwide with an estimated 24.7 million active users in 2015 survey while in Malaysia is around 66.4% which are 85,707 people out of total 129,092 drug abuser [1] in 2022. It is sold illegally and common presentation is related to central nervous system like psychosis. There is a case in which the patient presented with chest pain after ingesting a high amount of amphetamine tablets with normal conscious level and electrocardiogram (ECG) finding but had kidney impairment and high creatine kinase level (CK) most likely rhabdomyolysis. He was started with hyper hydration for a few days but kidney function worsened until he required dialysis with hemodiafiltration (HDF). He was improving with a reduction of serum creatinine (creat) and CK level more than half and was discharged. During post-discharge clinic follow-up, the kidney function result showed recovery. Substance-induced rhabdomyolysis is rarely reported compared to drug-induced rhabdomyolysis and always associated with concomitant infection. In this case, we can apply our knowledge in managing rhabdomyolysis not only by hydration but with intervention using special type of dialysis method to save kidney.

Keywords

Methamphetamine, Rhabdomyolysis, Creatine kinase, Hemodiafiltration

Abbreviation

Bpm: Beats Per Minute, Ca: Calcium, CK: Creatine Kinase, Creat: Creatinine, ECG: Electrocardiogram; HDF: Hemodiafiltration; K: Potassium; LDH: Lactate Dehydrogenase; Na: Sodium; NR: Normal Range; PO₄: Phosphate; RBC: Red Blood Cells; UA: Uric Acid

Introduction

Rhabdomyolysis is a clinical syndrome that leads to kidney injury. There was a case related to substance induced rhabdomyolysis requiring dialysis identified which is an amphetamine with atypical presentation to the hospital. Rarely have we heard that amphetamine alone can cause kidney injury unless it is combined with other pathology.

Case Description

A 26-year-old male chronic amphetamine abuser and dealer was brought to our emergency department after a complaint of chest discomfort and palpitations 6 hours after ingesting 50 pills of methamphetamine while trying to escape from enforcement officer. The methamphetamine pills were meant for smoke and inhale purpose before use instead of directly ingesting.

He denied other symptoms such as nausea, vomiting, abdominal pain, headache, hallucination, excessive sweating, seizure or dark colored urine. On

presentation he was alert, conscious, well orientated to time, place and person and not agitated. His blood pressure was 136/79 mmHg, heart rate of 140 bpm with respiratory rate of 22 breaths/min and temperature of 36.7° Celsius. His pupils were dilated 5 mm bilaterally. Systemic examinations of cardiovascular, respiratory and neurological examinations were unremarkable. ECG sinus tachycardia. Initial lab investigations revealed leucocytosis with white cell counts of $26.5 \times 10^9/L$ (NR 3.8-9.7), hemoglobin 16.4 g/dL (NR: 13.5-17.4), hematocrit of 46.4% (NR: 37.5-49.8) and platelet counts of $365 \times 10^9/L$ (NR: 167-376). His urine analysis showed protein and ketone 1 + while RBC, cast and leukocyte were negative. Urine toxicology was strongly positive for methamphetamine with value of more than 2000 mg/ml. There was kidney impairment with urea of 3.9 mmol/L (NR: 1.7-8.3), serum creatinine of 154 $\mu\text{mol/L}$ (NR: 70-130) and uric acid was significantly elevated with value of 1003 $\mu\text{mol/L}$ (NR: 210-420). Lactate dehydrogenase (LDH) and CK markedly raised as well with 1403 $\mu\text{mol/L}$ and 3454 mmol/L respectively thus raised higher suspicion of rhabdomyolysis. However, his blood gas was still normal initially with no metabolic or lactate acidosis. Chest radiograph no cardiomegaly or abnormal lung field.

Treatment

He was immediately started on hyperhydration for 3 days with good urine output of 2000 ml - 3000 ml and positive balance of 700 ml - 1700 ml every day and less tachycardia clinically however his serial serum creatinine and CK level parameters worsened leading to nephrologist consultation in which dialysis with hemodiafiltration (HDF) was initiated. He underwent 4 uneventful HDF sessions.

Outcome and Follow Up

His clinical and biochemical result showed markedly improvement (Table 1). The highest serum creatinine

level 326 $\mu\text{mol/L}$ had reduced to 166 $\mu\text{mol/L}$ while CK 8150 mmol/L reduced to 426 mmol/L after few sessions of HDF. He was discharged home well. Repeated parameters 2 weeks post discharged showed further improvement with kidney function and CK level returned to baseline (Table 1).

Discussion

Methamphetamine is the most common illegal drug abuse in Asia. Methamphetamine abuse has significant impacts on mental health, renal and cardiovascular complications. One of the known life-threatening complications of methamphetamine is rhabdomyolysis. Based on a study in USA in 2015 up to 20% of methamphetamine abuser we found to develop rhabdomyolysis [2]. Only a small minority (2.4%) of this number with rhabdomyolysis required intervention. However delayed diagnosis and intervention of rhabdomyolysis is heavily associated with irreversible kidney injury potentially leading to its complications and death. It is a clinical syndrome which is characterized as a result of disintegration of striated muscle and the leakage of muscle cells content including creatinine kinase and myoglobin. Clinically, rhabdomyolysis manifested classically as triad of muscle pain, weakness and dark coloured urine. However, the majority of rhabdomyolysis patients did not have all these three specific symptoms at time of diagnosis [3].

The manifestation of rhabdomyolysis depends largely on its etiology which makes it more challenging to diagnose. Therefore, a thorough history should be drawn up in order to make a timely diagnosis and proper intervention can be offered before complications occurred. Elevated CK is the telltale sign for acute rhabdomyolysis as a result of muscle damage. Rhabdomyolysis is considered when there is 5 times increment of CK from the upper limit [3]. Our case illustration had CK level more than 10 times upper limit

Table 1: Table shows the flowchart of kidney function of the patient.

Day of admission	1	2	3	5	6	7	8	2 weeks after discharge	4 weeks after discharge
Na (mmol/L)	135	139	134	140	135	138	140	138	138
K (mmol/L)	4.1	3.9	4.0	3.6	3.6	3.5	3.7	4.4	3.7
Urea (mmol/L)	3.9	5.6	7.1	3.7	3.5	3.7	3.7	4.0	2.7
Creatinine ($\mu\text{mol/L}$)	154	240	326	206	157	181	166	121	102
Uric acid (mmol/L)	1003		563					335	322
Ca (mmol/L)	2.15	2.09	2.19	2.14	1.93		2.04	2.31	2.23
PO ₄ (mmol/L)	0.89	1.39	1.12	0.97	1.02		0.91	1.06	1.03
Creatine kinase (CK) U/L	3450	3126	8150	5189	3633	1976	429		189
LDH (U/L)	1403								
Albumin g/L	49	43			35	35		45	46

Normal range: Na (sodium) 135-145 mmol/L; K (Potassium) 3.5-4.0 mmol/L; urea 1.7-8.3 mmol/L; serum creatinine 70-130 $\mu\text{mol/L}$; uric acid 210-410 $\mu\text{mol/L}$; Ca (Calcium) 2.02-2.60 mmol/L; PO₄ (Phosphate) 0.87-1.45 mmol/L; CK 30-200 U/L; Serum Albumin 38-44 g/L. No normal range for LDH (lactate dehydrogenase).

normal which make the diagnosis of rhabdomyolysis more likely despite not having dark colored urine as a result of myoglobin released into the urine. It is estimated that up to 50% of rhabdomyolysis patient had this dark-colored urine during the acute event. Myoglobinuria may not be detected in most cases due to its rapid metabolism and shorter half-life with its sensitivity in rhabdomyolysis only 25% [3].

The majority of rhabdomyolysis cases do not require treatment. However, this condition should be closely monitored as it is potentially fatal once it progresses unnoticed. Acute kidney failure is the most serious late complication from rhabdomyolysis which occurred in about 15% among the patients with this condition [4]. The main stay of treatments is largely supportive with the aim of preventing acute renal failure and complications. Early and aggressive fluid administration must be initiated in order to prevent hypovolemic leading to acute renal failure as a result of extracellular shift of fluid into the injured muscle cells. It is estimated that up to 12% of fluid maybe loss through this mechanism [5]. Generally, up to 1.5 L per hour of intravenous fluid must be administered initially with the aim of having urine output production of 300 ml per hour until condition improves. This approach should be maintained until CK level shows downtrend or below 1000 unit per litre [4].

Historically forced alkaline diuresis has been the standard of care in rhabdomyolysis. It is thought that urine alkalinization approach by using sodium bicarbonate can reduce renal tubular obstruction thus potentially renal protective. It should be used in caution in case of established oliguria as a result of acute kidney injury. To date, systemic review demonstrated no benefit is shown in term of the use of any pharmacotherapy agent beyond crystalloid in preventing acute renal failure from rhabdomyolysis [6].

Kidney replacement therapy (KRT) is another modality approach for rhabdomyolysis particularly for patients who have contraindication for aggressive fluid resuscitation. It helps to improve myoglobin clearance which can reduce renal tubular precipitation thus promoting renal recovery. Hemodiafiltration (HDF) is a preferred choice of renal replacement therapy due to its high permeability to filter out myoglobin which has big molecular size up to 17 kDA [6]. Our case scenario demonstrated marked improvement of CK clearance following several hemodiafiltration sessions. Subsequent follow up showed complete recovery of renal function for our patient [7].

Conclusion

Clinicians should have high suspicion of rhabdomyolysis in patients with suspected illicit drug abuse or overdose. Elevated CK is the hallmark of rhabdomyolysis. Initial management of rhabdomyolysis includes early aggressive hydration with normal saline

and supportive care. Early renal replacement therapy, preferably hemodiafiltration, is warranted if no clinical improvement observed from the supportive care as it offers better clearance for myoglobin compared to standard hemodialysis.

Acknowledgement

I would like to thank Dr Nurlzat Muhamad and Dr Wan Hasnul Halimi for their significant support and insight that help me complete this work. My heartfelt gratitude also goes to my other co-authors, Dr Abdul Hanan Abdullah and Dr Mohamad Najmi Ahmad for their support of main text and ideas for discussion.

This work would not have been possible without the support from colleague of Nephrology and CKD unit of Universiti Sains Malaysia (USM) which are Dr Muhd Imran Kamaruddin as well as Dr Wan Mohammad Khairul from Nephrology Department of Hospital Raja Perempuan Zainab 2, Kelantan Malaysia and my supportive colleagues from USM Internal Medicine Department.

I would like to thank my parents, whose love and guidance are with me in whatever I pursue. They are the ultimate role models.

Sources of Support

Not applicable.

Statement of Equal Authors' Contribution

NIM contributed from the main text and discussion and to the writing of the manuscript. AHA and MNA contributed on main text and result. WHH contributed to the idea and discussion. NHA contribute from abstract, main document, writing and editing.

References

- <https://www.adk.gov.my/infografik-statistik-penyalah-guna-dan-penagih-dadah-serta-bahan-bagi-bulan-januari-september-2022>
- Richards JR, Wang CG, Fontenette RW, Stuart RP, McMahon KF, et al. (2020) Rhabdomyolysis, methamphetamine, amphetamine and MDMA Use: Associated factors and risks. *J Dual Diagn* 16: 429-437.
- Stanley M, Chippa V, Aeddula NR, Rodriguez BSQ, Adigun R (2023) Ongoing Education Undertaking.
- Sauret JM, Marinides G, Wang GK (2002) Rhabdomyolysis. *Am Fam Physician* 65: 907-912.
- Odeh M (1991) The role of reperfusion-induced injury in the pathogenesis of the crush syndrome. *N Engl J Med* 324: 1417-1422.
- Burgess S (2022) Rhabdomyolysis: An evidence-based approach. *J Intensive Care Soc* 23: 513-517.
- Torres PA, Helmstetter JA, Kaye AM, Kaye AD (2015) Rhabdomyolysis: Pathogenesis, diagnosis, and treatment. *Ochsner J* 15: 58-69.