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Rhabdomyolysis after the Intake of Illicit Drugs as a Cause of Acute Renal Failure

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Abstract

Background: Rhabdomyolysis (RM) is striate muscle-cell damage with the release of intracellular substances to the circulation—myoglobin, muscular enzymes, potassium, etc., with or without the development of acute renal injury. RM due to the intake of illicit and controlled substances, including cocaine, amphetamine and its derivates, cannabis, and alcohol abuse is a common cause of acute renal failure in adolescents and adults. Aim: to alert clinicians to the need of early diagnosis and treatment of RM due to the intake of controlled substances and energy drinks. Case Presentation: We describe a 20-year-old male patient with acute renal failure due to rhabdomyolysis after the intake of controlled substances, energy drinks, physical efforts and dehydration. The renal biopsy revealed acute tubular injury. After rehydration, alkalization, temporary dialysis treatment, intravenous corticosteroids and symptomatic treatment the patient restored renal function. Conclusion: RM can be a severe life-threatening complication of the intake of controlled substances combined with strenuous physical activity, energy drinks and dehydration. The described case represents a typical scenario of RM developing secondary to controlled substance abuse in combination with alcohol and strenuous physical activity. The prompt diagnosis and the timely initiation of supportive (rehydration and alkalization) and corticosteroid therapy and the early dialysis lead to fast resolution of renal failure. The clinicians should keep in mind illicit drugs, alcohol and energy drinks and physical efforts as possible triggers of RM and acute kidney injury, especially in young people.

Keywords

Rhabdomyolysis, Acute Renal Failure, MDMA, Cannabis, Energy Drinks,

Dehydration, Treatment

1. Introduction

Rhabdomyolysis (RM) is striate muscle-cell damage with the release of intracellular substances to the circulation—myoglobin, muscular enzymes, potassium, etc., with or without the development of acute renal injury [1]. The major laboratory markers of RM are: increased levels of myoglobin in the plasma/serum and urine and plasma/serum levels of creatin kinase, lactate dehydrogenase and amino transferase, high potassium, uric acid and phosphate plasma/serum levels, metabolic acidosis, hypercoagulation and changes in calcium levels (both hypo- and hypercalcemia) can be observed [1] [2] [3] [4]. RM can be caused by a wide spectrum of metabolic, traumatic and infectious agents and can be classified as *traumatic* (after muscle physical trauma, electrocution, muscular compression/immobilization) and *non-traumatic* (after physical exercise, thermal trauma, muscle hypoperfusion, in infections, intoxications, use of certain prescription or illicit drugs, electrolyte and endocrinological disturbances, autoimmune and genetic diseases of the muscles and metabolism, or idiopathic) [1] [2] [3] [4] [5].

The intake of illicit drugs (e.g., cocaine, amphetamine, 3,4-mthyl enedioxy methamphetamine [MDMA, ecstasy], cannabis, and heroin) is becoming one of the most common causes of RM in adolescents and adults, especially in combination with alcohol and energy drinks and after strenuous physical efforts (dancing and/or training) [1] [3] [4] [5]. The underlying mechanisms of RM in illicit drug intake include: changes in vascular tone and muscle hypoperfusion, muscular trauma (in drug-induces changes of consciousness with long-term muscular compression), changes in body temperature (hypo- or hyperthermia), hypoglycemia and/or acidosis, dehydration, striate muscle-cell energy depletion, direct toxicity. The ingestion of energy drinks and the strenuous physical exercises, including dancing and training, the decreased water and electrolyte intake due to the euphoria state or loss of consciousness further aggravate the myotoxic effects of acidosis, hypo/hyperthermia and hypoperfusion. The possible complications include: acute kidney injury, muscle injury with water and electrolyte sequestration (further hypovolemia, hypokalemia and hypocalcemia) increase of potassium, phosphate and calcium levels, and disseminated intravascular coagulation [3]. The proper treatment in such cases includes supportive measures, rehydration, alkalization of the urine, and temporary dialysis [3]. The key element in the treatment is to quickly recognize RM, because the majority of patients deny the intake of illicit substances, and to initiate supportive treatment and, if ineffective-dialysis.

The aim of this presentation is to alert clinicians to the need of early diagnosis and treatment of RM due to the intake of controlled substances and energy drinks.

2. Clinical Case

A 20-year-old male Caucasian patient was admitted to the Clinic of Nephrology in June 2021 for acute renal failure. At the admission he reported fatigue, muscle pains, pain in the epigastrium and abdominal flanks, high fever (up to 38.5˚C), nausea and vomiting, decreased urine output for the past two days to <100 ml for the past 12 hours. The past history was unremarkable; the patient reported no family history, no allergies. He reported smoking approximately 20 cigarettes per day for the past 4 years. At the admission he denied drug and alcohol abuse. The physical examination revealed marked dehydration, low grade fever (37.6˚C), pale skin and linings, pain in the upper abdomen, positive renal succussion, excoriations and contusion wounds on hands and feet. Pulse rate 74 bpm, arterial blood pressure 120/80 mm·Hg. Written informed consent was obtained from the patient prior to any medical procedures and concerning the use and presentation of the obtained data.

At the admission, the baseline clinical-laboratory investigations revealed normal complete blood count, total protein and albumin levels and electrolytemia, significantly increased serum creatinine, urea, uric acid, phosphate levels, decompensated metabolic acidosis and increased urine protein loss (Table 1). Coagulation studies revealed no abnormalities. HBs antigen, anti-HCV antibodies, HIV, ANA, ANCA, anti-GBM, ACL antibodies were negative, C3 and C4 complement fractions were within the normal limits. Urine investigations revealed pH 5, specific gravity 1025, positive protein and blood, urinary sediment: 1 - 2 RBC, 4 - 5 WBC/pf. The microbiological investigation of the urine revealed no bacterial growth.

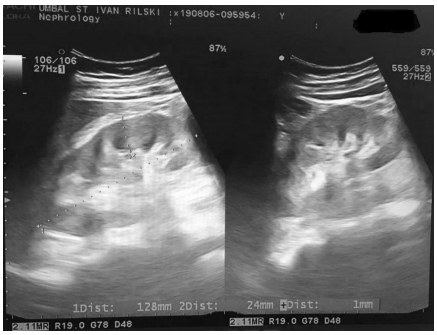
Table 1. Baseline clinical-laboratory investigations.

Parameter	Value	Normal limits
Creatinine	936 mcmol/l	<96 mcmol/l
Urea	29.8 mmol/l	1.7 - 8.2 mmol/l
Sodium	135 mmol/l	135 - 151 mmol/l
Potassium	4.1 mmol/l	3.5 - 5.6 mmol/l
Chlorides	98 mmol/l	93 - 112 mmol/l
Total protein	68 g/l	64 - 83 g/l
Albumin	42 g/l	35 - 55 g/l
Calcium	2.25 mmol/l	2.15 - 2.50 mmol/l
Phosphate	3.03 mmol/l	0.81 - 1.45 mmol/l
Uric acid	830 mcmol/l	142 - 340 mcmol/l
Creatin kinase	1004 U/l	24 - 170 U/l
pH	7.31	7.35 - 7.45
Base excess	(−7.6) mmol/l	±2.5 mmol/l
Urine protein loss	400 mg/l	<150 mg/l

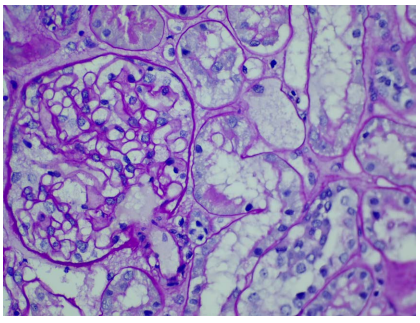
Abdominal ultrasound revealed (Figure 1(a)) increased liver echogenicity, both kidneys presented enlarged to 128 mm, with thickened and hyperechogenic parenchyma 23 - 25 mm with clearly visible contrasting hypoechogenic pyramids. RI of arcuate artery was increased to 0.8. The rest of abdominal parenchymal organs showed no pathological findings.

The patient underwent renal biopsy (Figure 1(b) and Figure 1(c)): no significant glomerular or vascular changes were detected, some of the tubules showed atrophic changes and degenerative changes affected tubular epithelial cells with loss of brush borders and eosinophilic material includes protein or cell debris within the tubular lumina. The immunofluorescence showed 1+ mesangial deposition of IgM and 1+ C3 deposition in vascular walls.

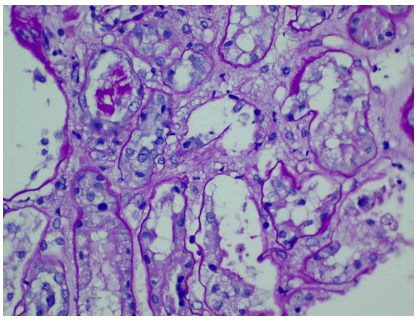
Rehydration with 0.9% NaCl saline and 5% glucose solutions, alkalization with intravenous sodium bicarbonate, gastroprotection with intravenous famotidine, intravenous corticosteroids and diuretics were started. Due to the lack of sufficient effect on diuresis despite the adequate rehydration and diuretic treatment, the patient was started on dialysis and three dialysis sessions were performed. After the third session polyuria initiated and serum creatinine fell to 165 mcmol/l, creatin kinase to 39 U/l, serum phosphates – to 0.98 mmol/l, uric acid – to 329 mcmol/l, urea – to 8.3 mmol/l. Urine protein loss decreased to 40 mg/l.



(a)



(b)



(c)

Figure 1. Abdominal ultrasound and renal biopsy findings. (a) Abdominal ultrasound—both kidneys are enlarged in size with increased parenchymal echogenicity and contrasting hypoechogenic renal pyramids. (b) and (c) Renal biopsy showing no significant glomerular changes (b) and mild tubular degenerative and atrophic changes with accumulation of eosinophilic material and cell debris inside the tubular lumina (c) (PAS, magnification ×400).

After repeated questions concerning drug and alcohol intake, during the hospital stay the patient reluctantly reported consuming alcohol in combination with energy drinks, MDMA and cannabis and dancing the night with friends five days before the admission.

The patient was discharged on day 10 of the hospital stay with no clinical symptoms, restored diuresis, mild elevation of serum creatinine to 165 mcmol/l, normal urea, uric acid and phosphate levels. After the discharge he was invited for a follow-up visit to the Clinic on day 7 and 14 after the discharge but did not show up to the control visits.

3. Discussion

RM is a complex medical condition with rapid degradation of damaged or injured skeletal muscles, presenting with the clinical triad of muscle pain and weakness, high serum creatine kinase and myoglobinuria [1] [3]. It can lead to the development of acute renal failure due to obstruction of renal tubules by myoglobin precipitates and/or toxic effects of muscle degradation products on renal tubular cells. RM may develop due to a wide range of traumatic and non-traumatic insults (metabolic, infectious, immune-mediated and toxic), including drugs [3] [6] [7]. RM may lead to severe renal damage, acute and chronic kidney injury requiring temporary or long-term renal-replacement therapy [6] [7] [8].

Several controlled substances have been described to cause RM, including opioids, amphetamine derivates, cocaine, cannabis, LSD, phencyclidine [1] [3] [6] [7] [8] [9], especially in combination with strenuous physical efforts/activity and energy drinks [5]. In cases of energy drink intake in combination with controlled substances, the RM could lead to acute renal injury with mild increase in creatine kinase levels, probably due to volume depletion and the development of tubulo-interstitial toxicity and inflammation secondary to caffeine in energy drinks [10]. Acute alcohol intoxication could also lead to RM and could exacerbate RM in patients with illicit drug intake [11] [12].

The present clinical case is a typical patient with acute renal failure due to the intake of illicit substances (MDMA and cannabis) in combination with alcohol and energy drinks and strenuous physical activity with dehydration and muscle damage. The patient sought medical help five days after the drug intake and physical activity when urine output decreased. The typical biochemical constellation of rhabdomyolysis-associated acute renal failure was detected: increased creatinine, uric acid, urea and phosphate levels and increased creatin kinase. The abdominal ultrasound revealed diffuse infiltrative renal parenchymal disease with increased renal and parenchyma size and high parenchymal echogenicity with contrasting pyramids. Renal biopsy revealed no significant glomerular or vascular abnormalities, and showed mild tubular changes. The timely discovery of the cause of acute renal injury, the team approach with the participation of nephrologist, intensive care specialist, dialysist and pathologist, and the prompt initiation of adequate treatment despite the 5 days delay between the initiation of

rhabdomyolysis and the presentation of the patient to the Clinic ensured the successful outcome with rapid restoration of diuresis and decrease in creatinine, urea, uric acid, phosphate and creatin kinase levels.

In conclusion, the described case represents a typical scenario of RM developing secondary to controlled substance abuse in combination with alcohol and strenuous physical activity. The prompt diagnosis and the timely initiation of supportive (rehydration and alkalization) and corticosteroid therapy and the early dialysis lead to fast resolution of renal failure. The clinicians should keep in mind illicit drugs, alcohol and energy drinks and physical efforts as possible triggers of RM and acute kidney injury, especially in young people.

Conflicts of Interest

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

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