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A Case Report on Caffeine-induced Psychological Disorders and Acute Kidney Injury Following Excessive Energy Drink Consumption

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ABSTRACT

Here, we report a 20-year-old male patient who developed acute kidney injury after consuming six cans of energy drinks daily for the last week. His daily intake amounted to about 426 mg of caffeine and 2268 mg of taurine. He was also diagnosed with caffeine intoxication and caffeine withdrawal at the time of his hospitalization. Considering the potential damage of energy drinks may cause to people's health, this case calls for regulations on their use.

Keywords: Acute kidney injury, adverse effect, caffeine intoxication, caffeine withdrawal, energy drinks

INTRODUCTION

Although energy drinks (ED) were initially introduced to the market and aimed to increase exercise performance, due to the caffeine and other substances they contain, it has been used for alternative purposes for many years.[1] Most ED ingredients contain caffeine, L-carnitine, taurine, B vitamins, glucuronolactone, antioxidants, trace minerals, guarana, sucrose, Ginkgo biloba, and/or ginseng, which act as stimulants.[2] Caffeine, or 1,3,7-trimethylxanthine, is a stimulant that promotes alertness. It blocks the adenosine receptor, increasing intracellular calcium concentration and promoting catecholamine release.[3] As a result, energy drinks are increasingly popular among certain groups. Reports to the Food and Drug Administration (FDA) include a range of adverse effects, such as psychiatric symptoms, arrhythmia, cardiac arrest, myocardial infarction, convulsions, and kidney injury.[4] We report an acute kidney injury observed in a case of caffeine intoxication following excessive energy drink consumption.

CASE REPORT

A 20-year-old male patient was admitted to the emergency room due to severe back and abdominal pain, nausea, and dizziness. The patient, who worked as a hostess and frequently had night shifts, had been consuming excessive amounts of energy drinks for the past year. For the last week, he had been drinking 6 cans of energy drinks a day. He had no complaints of vomiting or diarrhea. No history of psychiatric or physical illness, alcohol or smoking usage, and a family history of mental or physical illness.

Physical examination revealed a blood pressure of 121/80 mm Hg, heart rate of 75 bpm, respiratory rate of 20 breaths/min, temperature of 36.5 C, and O2 saturation of 99% on room air. After a thorough examination, the electrocardiography and chest radiography did not reveal any pathological findings. His heart and abdominal examinations were normal. His laboratory findings were as follows: serum creatinine (SCr): 1.57 mg/dL, BUN: 20 mg/dL. The parameters for arterial blood gases were pH:

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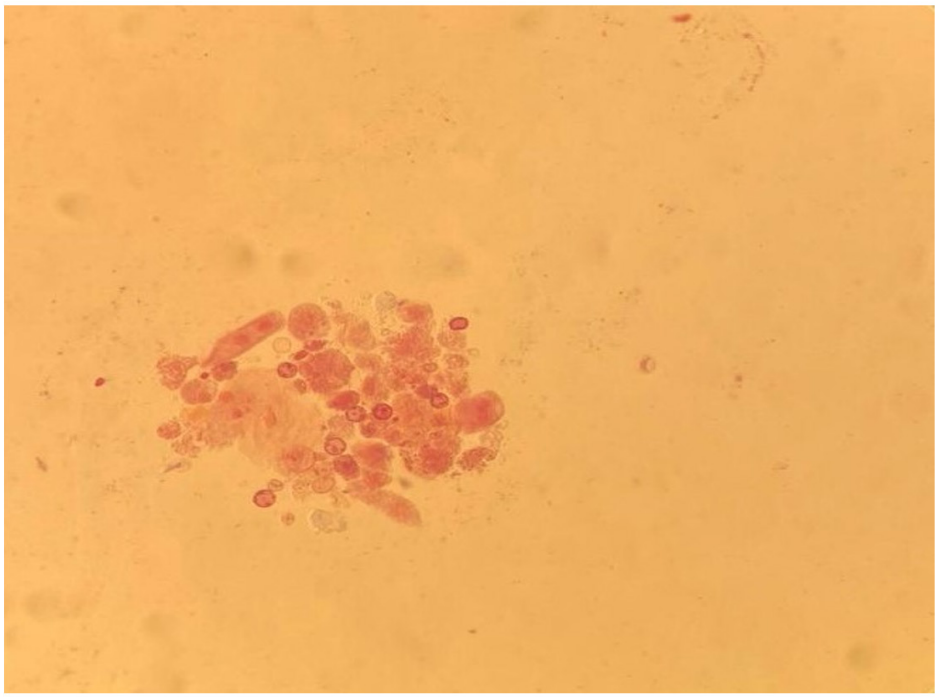

Figure 1. Epithelial cells and leukocytes in the urine sediment

7.27, HCO_3: 29.1 mmol/L, PCO_2: 64.2, and Lac: 2.27 mmHg. The estimated glomerular filtration rate (eGFR) was 62.52 (mL/min/1.73 m2). Previous laboratory analysis one year prior had revealed a BUN of 7,5 mg/dL and SCr of 0.9 mg/dL. Measurement of total blood count, clotting parameters, electrolytes, and liver enzymes were within normal ranges over the course of the treatment. Also, urinalysis was normal. No acute lesion was observed in the abdomen ultrasound imaging and both kidneys were normal in size. Because of type B hyperlactatemia, the patient was monitored in the intensive care unit for a day. The excessive intake of caffeine was linked to the consumption of six cans of energy drinks per day in the last week according to the anamnesis taken from the patient.

On the second day, the patient was transferred to the internal medicine service for evaluation of acute kidney injury. His fractional sodium excretion was calculated at 7% and BUN/SCr was 12.7 (<20). His renal failure index was 10.58 (>1). There were epithelial cell casts in the patient's urine sediment (Figure 1). Findings were consistent with acute kidney injury. Serum albumin, protein, calcium, uric acid, and hematocrit levels were in the normal range. The daily urine samples tested negative for leukocytes, nitrite, ketone, and bilirubin and revealed normal levels of glucose and urobilinogen. Also, HIV antibodies and hepatitis serology were negative. The patient's serum creatinine levels gradually decreased to normal over one week (Table 1).

The patient reported severe headaches, back pain, skin flushing, depressed mood, and irritability after one week of discontinuation of energy drinks. The patient was consulted by psychiatry due to caffeine withdrawal. Sertraline 25 mg and Ketiapin 25 mg were started. The patient was discharged after seven days in the hospital after a re-examination by a psychiatrist due to the regression of the patient's symptoms. Cognitive therapy was recommended, and outpatient

Table 1. Blood and Urine Chemistry Values

Reference Time Point	SCr (mg/dL)	BUN (mg/dL)	Estimated GFR (mL/min/1.73 m^2)
1 year before the presentation	0.9	7.5	124
Day 1	1.57	20	62,52
Day 3	1.52	9.2	65,02
Day 7	1.1	10	95,08
3 Weeks After Presentation	0.8	7	125

Abbreviations: eGFR: estimated glomerular filtration rate, SCr: serum creatinine, BUN: blood urea nitrogen.

follow-up was without pathologic finding three weeks after discharge.

DISCUSSION

BMS poses a diagnostic and therapeutic chaIn this casThe popularity of energy drinks has increased in the last two decades.[3] One of the reasons for this situation is the marketing of energy drinks to young adults and adolescents by beverage companies.[5] Some adverse effects have previously been reported due to excessive consumption of energy drinks. These may be cardiac, gastrointestinal, neurological, and nephrological side effects.[1] It has been reported that some fatal cases.[2] Also, we underline that caffeine-induced psychological disorders should not be forgotten. Adverse nephrological side effects of energy drinks were reported in a review published by Costantino A. et al.[1] We also observed one of these adverse nephrological effects in our patient.

Table 2. Ingredients of the energy drink consumed by the patient

Ingredient	Amount
Caffeine	150 mg/L
Taurin	800 mg/L
Niacin	8mg / 50% RDA per 100ml
Pantotenik Acid	2mg / 33% RDA per 100ml
B6	2 mg/ 143% RDA per 100ml
B12	2 mcg/ 80% RDA per 100ml

RDA: Recommended Daily Allowance

The patient was drinking six of the (473 mL) 16-oz energy drinks per day. This equates to approximately 426 mg of caffeine daily (Table 2). Although caffeine is the primary psychoactive ingredient in energy drinks, acute kidney injury resulting from caffeine intake alone has not yet been reported. Some cases of acute kidney injury have been reported due to the taurine substance found in energy drinks. Schöffl et al. reported acute kidney injury in a 17-year-old male patient after consuming 3L of energy drinks and 1L of vodka. The patient had an intake of 780 mg caffeine and 4600 mg taurine.[7] Another case is a 40-year-old male patient who developed acute kidney injury after consuming 6 16. oz energy drinks a day was reported by Greene E. et al.[8] The patient had many additional diseases in his medical history, such as diabetes mellitus type 2, hypertension, gout, and alcohol abuse. Furthermore, the patient was taking multiple medications, specifically NSAIDs. It was difficult to determine the etiology due to diabetes and the medications he used. In our case, the patient had no chronic disease, no alcohol addiction, and no drug use shows us more clearly the development of acute kidney injury after the energy drink.

A common nutritional supplement taken by athletes to enhance performance is taurine, an amino acid that contains sulfur. Suliman et al.[9] reported that the use of taurine in end-stage renal disease patients is risky in their study. Additionally, Al Yacoub R et al.[10] presented a case in which acute kidney injury and acute hepatitis developed simultaneously after consuming six cans of 16 oz energy drinks per day. They reported that acute kidney injury was most likely due to taurine, and acute hepatitis was due to niacin. The side effects of energy drinks have been tested experimentally using animal models. Histopathological effects of energy drinks on the liver, kidneys, heart, and brain were studied by Salih et al. using rabbits as an animal model. Their findings suggest a direct correlation between tissue damage and the dose administered. At higher doses, they observed renal vascular congestion, the bleeding of interstitial tissue, focal atrophy, and the degeneration of the lining epithelium of the proximal and distal convoluted tubules.[11] Rasheed et al.[12] showed histopathological changes such as increased tubular vacuolization in renal tubular cells in rats exposed to energy drinks. Since our patient's laboratory findings and clinical condition improved after IV hydration, a kidney biopsy was not necessary in this case. Therefore, considering that the patient had been consuming excessive amounts of energy drinks for the last year, it was not possible to determine whether there was any chronic damage. (Such as interstitial fibrosis, lymphocyte and plasma cell infiltration observed in chronic interstitial nephritis).

There have been reports on the connection between caffeine use and caffeine-induced psychological disorders.[6] The Diagnostic and Statistical Manual for Mental Disorders, 5th Edition (DSM-5) proposes 4 caffeine-related syndromes.[13] Our case fulfills the criteria for diagnosis of "Caffeine Intoxication" and "Caffeine Withdrawal" (Table 3, Table 4). Since the patient had not yet requested a psychiatric examination, we were unable to evaluate his psychiatric reversal after caffeine discontinuation.

In this case, we aimed to show how addiction can result in serious, even fatal, consequences like acute

Table 3. Diagnostic Criteria for Caffeine Intoxication

A. Recent consumption of caffeine (typically a high dose, more than 250 mg).
B. Five (or more) of the following signs or symptoms developing during, or shortly after, caffeine use: 1. Restlessness. 2. Nervousness. 3. Excitement. 4. Insomnia. 5. Flushed face. 6. Diuresis. 7. Gastrointestinal disturbance. 8. Muscle twitching. 9. Rambling flow of thought and speech. 10. Tachycardia or cardiac arrhythmia. 11. Periods of inexhaustibility. 12. Psychomotor agitation.
C. The signs or symptoms in Criterion B cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
D. The signs or symptoms are not attributable to another medical condition and are not better explained by another mental disorder, including intoxication with another substance.

Table 4. Diagnostic Criteria for Caffeine Withdrawal

A. Prolonged daily use of caffeine.
B. Abrupt cessation of or reduction in caffeine use, followed within 24 hours by three (or more) of the following signs or symptoms: 1. Headache. 2. Marked fatigue or drowsiness. 3. Dysphoric mood, depressed mood, or irritability. 4. Difficulty concentrating. 5. Flu-like symptoms (nausea, vomiting, or muscle pain/stiffness).
C. The signs or symptoms in Criterion B cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
D. The signs or symptoms are not associated with the physiological effects of another medical condition (e.g., migraine, viral illness) and are not better explained by another mental disorder, including intoxication or withdrawal from another substance.

kidney injury. Fortunately, our patient's acute kidney injury was treated, and his addiction was diagnosed. However, this condition could be more dangerous if it is not diagnosed on time, especially in patients with serious comorbidities.

CONCLUSION

Caffeine, which is also the main ingredient of energy drinks, can cause syndromes such as addiction and withdrawal. Hence, we advise that daily energy drink intake should not be above the caffeine safety limitations defined by regulatory authorities, and should even be lowered based on the information available in the literature. Furthermore, additional systematic investigations are necessary to clarify the long-term effects of energy drink intake on human health.

Author Contributions:

All of the authors declare that they have all participated in the design, execution, and analysis of the paper and that they have approved the final version. Ali Can Memiş is the article guarantor.

Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Ethical Statement

In accordance with ethical standards, all patient information was anonymized, and no formal ethics approval was necessary.

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