Characteristics and complications of acute cocaine intoxication

A cross-sectional study in an emergency room in Colombia

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DOI: https://doi.org/10.36104/amc.2022.2256

Abstract

Introduction: the use of cocaine has increased, and, with it, the number of emergency room visits and hospitalizations due to acute intoxication. The objective was to describe the characteristics and complications of patients with cocaine intoxication who were seen in the emergency room of a tertiary care hospital in Colombia.

Materials and methods: a cross-sectional study. Patients seen from 2016 to 2019 with cocaine intoxication, according to the medical chart and a positive cocaine test, and with no underlying diseases which would directly affect survival, were included. The sociodemographic and clinical characteristic were described, and the mortality and prevalence of complications were estimated.

Results: a total of 159 patients were included, mostly males, with a low educational level and a median age of 31 years. The mortality was 3.8%. The prevalence of acute kidney injury (AKI) was 29.6% (95%CI 22.6 – 37.3%), 8.8% (95%CI 4.3 – 14.3%) for acute liver failure (ALF), 4.4% (95%CI 1.8 – 8.9%) for acute myocardial infarction (AMI) and 4.4% (95% CI 1.8-8.9%) for cerebrovascular accident (CVA). Elevated creatine phosphokinase (CPK) levels were found to be greater than 1,000 in 80% of patients with AKI, 100% of those with ALF, and 50% of those with CVA.

Conclusion: acute cocaine intoxication causes multiple organ dysfunction, mainly of the kidneys and liver, which may be due to direct injury and possibly also due to muscle damage reflected in the elevated CPK. This could indicate the need for strict monitoring of this enzyme and research of its use as a prognostic variable. **(Acta Med Colomb 2022; 47. DOI: https://doi.org/10.36104/amc.2022.2256).**

Key words: *cocaine, cocaine-related disorders/complications, acute kidney injury, drug or substance-induced liver disease, rhabdomyolysis.*

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Received: 22/VII/2021 Accepted: 21/X/2021

Introduction

Cocaine is an alkaloid obtained from the leaves of the *Erythroxylum coca* bush (1). Its global production has increased over the last few years. According to the United Nations Office on Drugs and Crime (UNODC) World Drug Report 2019, coca cultivation in 2017 was estimated at 245,000 hectares, with 1,976 tons of cocaine produced, a 25% increase compared with 2016. This, in turn, is matched by increased consumption. In 2017, an estimated 18 million people around the world between the ages of 15 and 64 had used cocaine, which is equivalent to almost 0.4% of the population (2). According to the 2018 Global Drug Survey report, 36.7% of the more than 14,000 survey respondents had used cocaine at some time in their lives and 26.8% had used it within the last year (3). Colombia, despite the reported efforts, continues to be the main producer and distributor in the world (4). Consumption is also frequent, as approximately 162,000 Colombians used cocaine in the last year, which makes it the second most used illegal substance (5).

Cocaine use may lead to medical and psychosocial problems, including those related to crime and violence, and it is therefore considered to be a public health problem (6). It causes a stimulating effect with heightened awareness, emotional arousal, anxiety, irritability, tachycardia, hypertension, diaphoresis, nausea and even psychotic symptoms (7). Although it may vary according to the dose, route of administration and simultaneous consumption of other toxins, acute cocaine intoxication causes progressive abnormalities in different organs (8) explained by the inhibition of noradrenaline, dopamine and serotonin reuptake, which build up in the synaptic gap and cause sustained stimulation of sympathomimetic activity (9, 10). Complications range anywhere from kidney, liver, cardiovascular and neurologic complications to death.

The number of emergency room consultations and hospitalizations for intoxication and complications has also been growing, especially in urban areas (11-13). This increase may vary from one city to another and there are even variations in the number of consults depending on the market price (14). In addition, the complications of cocaine abuse may be unpredictable and the reasons for consulting may vary widely (15). Therefore, local information from the emergency rooms may be useful because it provides information on the health-related consequences as well as the patterns of use which may not be identified in other population data sources (16). Thus, the emergency rooms may be the first link in the toxicosurveillance network as they provide information on the epidemiology of the effects of cocaine and the factors related with the development of complications (17). The objective of this study was to describe the sociodemographic and clinical characteristics, as well as the mortality and prevalence of complications in cocaine-intoxicated patients who were seen in the emergency room of a high-complexity hospital in Colombia.

Methods

This was a descriptive cross-sectional study at Hospital Universitario San Vicente Fundación (HUSVF), a high-complexity hospital serving as a referral center in the Department of Antioquia, where patients from all socioeconomic levels are seen. It was approved by the institutional Ethics Committee and complies with the 2013 Declaration of Helsinki.

Participants

The selected patients were those who were admitted to the emergency room at HUSVF between 2016 and 2019 with a diagnosis of cocaine intoxication, according to the description in the medical chart, and who also had a positive quantitative or qualitative cocaine test on admission. Those with diseases which could affect their survival (cancer, chronic lung disease, kidney or liver disease), or who were admitted to the emergency room with serious trauma, or with concomitant acute intoxication or overdose of drugs or toxins other than ethanol or cannabis (THC) were excluded. Patients who did not have enough information in their medical chart to identify or rule out complications were excluded.

Data collection

The lists of patients in the toxicology service were evaluated, the medical charts of patients with cocaine or psychoactive drug use were selected, and these were analyzed one by one. Eligible cases were also sought in the list of patients undergoing urine cocaine tests, based on information from the hospital laboratory.

Variables

Sociodemographic (age, sex, marital status, educational level and health insurance regimen) and clinical (vital signs) characteristics were collected, along with admission lab tests (electrolytes, arterial gases, liver and kidney function, creatine phosphokinase -CPK-, troponin, blood alcohol level and urine toxins) and maximum peaks (highest recorded values of the variables) of transaminases, creatinine (Cr) and CPK. Blood alcohol levels were classified according to the Colombian National Institute of Forensic Medicine (18), the laboratory reference value (30-200 U/L) was used for CPK values, and rhabdomyolisis was defined as levels greater than 1,000 U/L (19).

The presence of acute kidney injury (AKI), acute liver failure (ALF), acute myocardial infarction (AMI), and cerebrovascular accident (CVA) was assessed. The creatinine (Cr)-based Kidney Disease: Improving Global Outcomes (KDIGO) classification was used to classify AKI: KDIGO 1 if creatinine is 1.5-1.9 times the baseline or has increased 0.3 mg/dL; KDIGO 2 if 2-2.9 times the baseline; and KDIGO 3 if it is three times the baseline, renal replacement therapy has been started, or the glomerular filtration rate has decreased to less than 35 ml/min (20). Acute liver failure was defined as aminotransferase elevation at twice the normal value (21). The medical chart diagnosis, following the hospital's protocols, was taken as an indicator of AMI and CVA. The status at discharge was reviewed to verify survival.

Statistical analysis

Qualitative characteristics were described using absolute and relative frequencies, and quantitative characteristics used median and interquartile range (IQR), as the Shapiro-Wilk test showed that they were not normally distributed. Mortality and the prevalence of complications were estimated with their respective 95% confidence intervals (95% CI). The differences in characteristics and laboratory values between patients with each complication were explored through a comparison of proportions using Fisher's exact test and a comparison of medians using the Mann-Whitney U test, as the assumption of normality and homoscedasticity was not met. A p less than 0.05 was considered to be statistically significant for all tests. The Stata® version 15.1 (*StataCorp LLC, USA*) statistical program was used.

Results

A total of 139 patients who were seen by the toxicology service were found, and 636 patients had a positive cocaine test, for a total of 775 eligible patients. Altogether, 614 were excluded, most due to having other intoxications or comorbidities, with 159 patients ultimately included (Figure 1).

Characteristics

The patients included were in their fourth decade of life, although there was a wide age range; they were male, single, and were affiliated with the subsidized health insurance regimen. On admission, the patients were normotensive and tachycardic, with only 25% of the patients having a heart

rate less than 100 bpm. The quantity of cocaine ingested was only recorded for 11 patients, with an average of 12.7 g, a minimum of 0.5 and a maximum of 50 g.

Regarding laboratory tests, the electrolyte values on admission were mostly within normal limits, as were bilirubin and INR. Seventy-five percent of the patients had a bicarbonate less than 22 mmol/L, with a median pH of 7.35, and 25% had some degree of inebriation on admission (Table 1). The admission creatinine was found to be 1.0 mg/dL (IQR: 0.84-1.3), and during the hospital stay it peaked at 1.05 (IQR: 0.85-1.35), for most (76%) on the first inpatient day. The median AST was 32 U/L (IQR: 23-53), reaching a median peak of 34 U/L (IQR: 24-58) for half on admission and for 38% between the second and third day. The median initial ALT was 24 U/L (IQR: 17- 37) with peak values of 25 U/L (IQR: 17-39), which were reached between the second and third day in 35% of the patients. Elevated CPK was found in 93 participants (81%), 28 of whom had levels over 1,000 U/L; the median CPK peak was 954 (IQR: 347-954), which was present on admission in half the patients and was reached by the rest on the first inpatient day.

Mortality

Six patients died during the hospital stay (3.8% mortality; 95% CI 1.4-8.0%). Their ages ranged from 32 to 38 years, and they were tachycardic and desaturated on admission, with increased transaminases, creatinine and CPK (five had CPK >1,000) and decreased levels of bicarbonate (Table 2). Concomitant alcohol ingestion was recorded for three patients and THC for two. In these cases, the complications were AKI coupled with ALF (n=5, 83.3%) and CVA (n=1; 16.7%).

Complications

There were complications in 56 individuals (a prevalence of 35.2%; 95% CI 27.8-43.2%). The main complication was AKI, followed by ALF. Some patients had a combination of complications: 10 AKI and ALF, 2 AMI and AKI and 1 CVA and ALF. The laboratory tests showed that the peak values of patients without complications were on admission, while the peak values of those with complications appeared on the second or third day.

Acute kidney injury: this was found in 47 participants (29.6% prevalence; 95% CI 22.6-37.3%). Most were classified as KDIGO 1 (n=34, 72%), six (13%) were KDIGO 2, and 7 (15%), were KDIGO 3. The median age for AKI was 32 years (IQR 24-39), and the median hospital stay was five days. They were admitted with normal blood pressures and tachycardia, with a median of 110 bpm (IQR: 88-130). The electrolyte laboratory results showed a median sodium of 141 mmol/L (IQR: 138-143), potassium of 3.9 mmol/L (IQR: 3.7-4.3) and magnesium of 2.4 mg/ml (IQR: 2.2-3.3), along with a positive THC test in 19 patients. Peak AST levels during hospitalization were greater in patients with AKI, with a median of 55 U/L (IQR 29-123), than in those who did not have AKI, with a median of 30 U/L (IQR: 23-

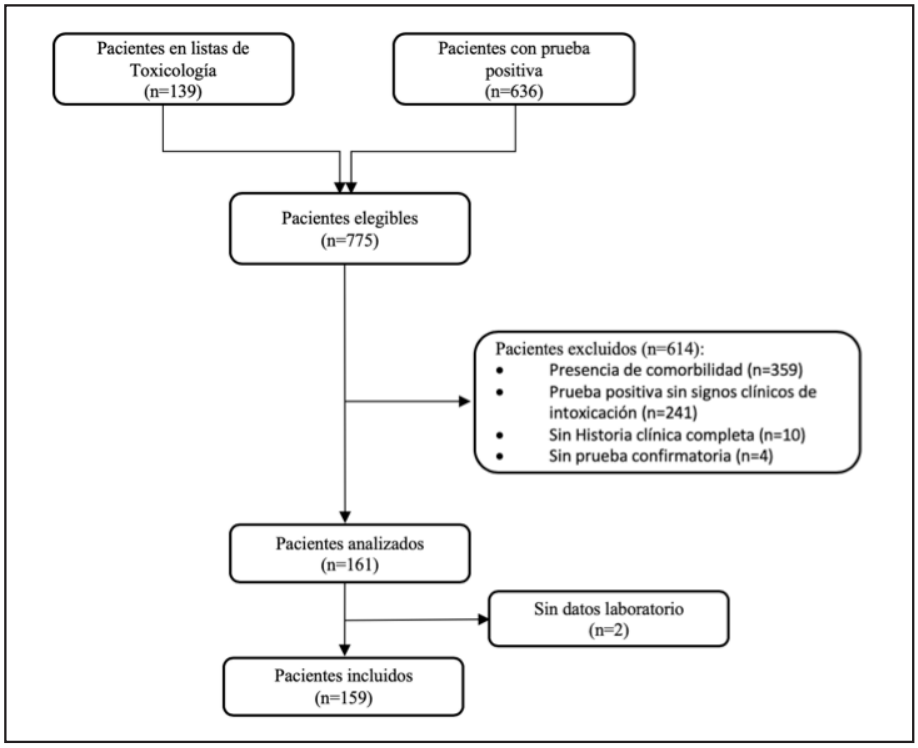

Figure 1. *Flowchart of patient inclusion and exclusion.*

44), which was statistically significant (p<0.0001). The CPK levels were significantly higher; 30 patients even reached CPKs over 1,000 (Table 3).

Acute liver failure: this was found in 14 people (8.8% prevalence; 95% CI 4.3-14.3%). In nine patients, the elevation was more than five times the normal ALT. On admission, six of the patients already had their highest level of ALT and ALT, while the rest exhibited these levels after the second inpatient day. The median highest ALT level during hospitalization was 721 U/L (IQR: 136-4,591) and for AST it was 185 U/L (IQR: 123-542). For those who had CPK levels drawn (12 patients), all had levels over 1,000 and significantly higher peak values, with a median of 18,175 U/L (IQR: 4,758-44,182). Ten of the patients had concurrent AKI.

Acute myocardial infarction: **this was** diagnosed in seven people (4.4% prevalence; 95% CI 1.8-8.9%), mostly males (86%), with a median age of 45 years (IQR: 29-62), which was older than the patients who did not have AMI, as their median age was 30 years (IQR: 22-38) (p=0.014). Patients with AMI had a hospital stay of four days and all survived. The median SAP on admission was 118 mmHg (IQR: 80-150) and the DAP was 80 mmHg (IQR: 60-87). The laboratory tests showed a median sodium of 138 mmol/L (IQR: 136-139), potassium of 4 mmol/L (IQR: 3.7-4.3) and magnesium of 2.2 mg/dL (IQR: 1.9-2.4). Forty-three percent of the cases had a positive THC test. Two patients had elevated CPK, but neither was over 1,000, and the median troponin was 1.26 (IQR: 0.3-4.5). None of the seven cases had detectable alcohol levels.

Cerebrovascular accident: this occurred in six individuals (4.4% prevalence; 95% CI 1.8-8.9%), with a median age of 33 years (IQR: 19-44). One patient in this group died. The median SAP was 128 mmHg (IQR: 112-204), DAP was 86 mmHg (IQR: 76-100), and HR was 108 bpm (IQR: 79-110). On the laboratory tests, all the patients except one had normal electrolytes, with one patient having hypokalemia (potassium = 2.6 mmol/L). Only one patient with CVA had a positive THC test, and three had elevated CPK over 1,000.

Discussion

A total of 159 patients with cocaine intoxication who were seen in the emergency room of a high-complexity hospital in Colombia were included. Their sociodemographic characteristics coincide with what has been reported in the literature on the profile of users. Most were young, similar to what other authors have reported (22), although interestingly, there was a wide age range. They were mostly males, with a low educational level and low to middle income, which could portray the complex relationship between poverty and cocaine use, as living with limited means is known to foster drug use and, in turn, drug use leads to unemployment and financial problems (23) as well as school desertion, which is reported in up to 32% of users (24).

Death occurred in 3.8% of the patients, mostly males, in the third decade of life, all with elevated CPK, and half with

Table 1. *Sociodemographic and clinical characteristics of patients with cocaine intoxication seen at a high-complexity hospital in Colombia during 2016 and 2019 (n=159).*

Variable	Result	
Age in years, Me (IQR)	31	(22 – 38)
Male sex, n (%)	132	(83)
Marital status, n (%)		
Single	85	(53.5)
Married or cohabitating	29	(18.2)
Separated	10	(6.3)
Widowed	1	(0.6)
Unkown	34	(21.4)
Subsidized regimen, n (%)	96	(60.4)
Schooling, n (%)		
Primary	57	(36)
Secondary	27	(17)
Technical or Technological	5	(3.1)
University	2	(1.2)
Unknown	68	(42.8)
Vital signs on admission, Me (IQR)		
SAP, mmHg	125	(114 – 140)
DAP, mmHg	78	(70 – 88)
HR, bpm	117	(100-140)
$SaO_{2,}$ %	98	(96-98)
Days of hospital stay, Me (IQR)	4	(3 – 8)
Admission tests, Me (IQR)		
Sodium, mmol/L	140	(138-142)
Potassium, mmol/L	4	(3.7-4.3)
Chloride, mmol/L	106	(103-108)
Magnesium, mg/dL	2.2	(1.9-2.4)
Calcium, mg/dL	9.6	(8.9-9.9)
Total bilirubin, mg/dL	0.7	(0.47-1)
AST U/L	32	(23-53)
ALT U/L	25	(17-37)
INR	1.0	(1.0-1.1)
Creatinine mg/dL	1.0	(0.84-1.3)
pH	7.35	(7.3 –7.41)
Bicarbonate mmol/L	21	(18 - 22)
CPK U/L	546	(224-1,475)
Tp ng/dL	0.0025	(0.001-0.12)
Level of drunkenness, n (%)	41	(25.8)
Level 1	10	(6.3)
Level 2	11	(7.0)
Level 3	20	(12.6)

Abbreviations: Me: median; IQR: interquartile range, SAP: Systolic arterial pressure, DAP: diastolic arterial pressure, HR: heart rate, SaO2: arterial oxygen saturation, AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, INR: international normalized ratio, CPK: creatine phosphokinase, Tp: troponin

Table 2. *Characteristics of patients with cocaine intoxication who did and did not survive after being seen in an emergency room in Colombia.*

Variable	Survivor (n=153)		Nonsurvivor (n=6)		P value *
Age in years, Me (IQR)	38	(32 - 39)	30	(22 - 38)	0.105
Male sex, n (%)	127	83	5	83	1.00
Laboratory tests, Me (IQR)					
Sodium, mmol/L	140	(138 - 142)	143	(138 - 145)	0.039
Potassium, mmol/L	4	(3.7 - 4.3)	3.8	(3.8 - 4.2)	0.464
pH	7.33	(7.02 - 7.35)	7.35	(7.30 - 7.42)	0.289
Bicarbonate, mmol/L	21.1	(19.2 - 21.1)	12.5	(11 - 17.6)	0.011
INR	1.09	(1.07 - 1.1)	1.0	(1 - 1.1)	0.587
AST, U/L	1.09	(1.07 - 1.1)	1.0	(1 - 1.1)	0.587
ALT, U/L	24	(17 - 36)	376	(366 - 772)	0.002
Total bilirubin, mg/dL	0.7	(0.5 - 0.7)	0.73	(0.46 - 1.03)	0.499
Creatinine, mg/dL	1.0	(0.8 - 1.3)	2.1	(1.0 - 2.6)	0.0131
Peak creatinine	1.04	(0.84 - 1.3)	4.6	(1.08 - 5.46)	0.0109
CPK, U/L	482	(214 - 1,377)	1,138	(1,038 - 14,660)	0.05
Peak CPK	838	(322 - 2,238)	5,845	(1,138-44,182)	0.027
AKI, n (%)	42	42/153	5	5/6	0.009
ALF, n (%)	13	13/153	1	1/14	<0.0001

Abbreviations: Me: median; IQR: interquartile range, INR: international normalized ratio AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, Cr: creatinine, CPK: creatine phosphokinase, AKI: acute kidney injury, ALF: acute liver failure.
* Corresponds to hypothesis tests using Fisher's exact test for proportions or the Mann-Whitney U test for comparing the medians from two independent samples.

concomitant alcohol consumption. This figure is slightly higher than that of another descriptive study of the problems associated with cocaine use in 233 patients, in which mortality reached 1% (25). This difference could be due to patients in that study being included by self-reported use and patients being included who did not necessarily have signs of intoxication, such as those who went for detoxification or were arrested by the police. The risk factors associated with mortality included the concomitant use of other substances, as was seen in an analysis of 533 deaths associated with cocaine use, which found that 84% had concomitant heroin use (26). Studies in New York City have reported being male, Hispanic or Black and having a positive blood alcohol test on autopsy as mortality risk factors (27, 28). The most common causes of death in pathology studies include cardiovascular problems followed by cerebrovascular problems (29), as we found in one of our cases.

Among the clinical complications, the most frequent was AKI, with a prevalence of 29.6%; this agrees with the literature which reports 25-30% (30). Acute kidney injury could be explained by the decreased perfusion caused by sympathetic activation following catecholamine reuptake inhibition (31) which triggers vasoconstriction, increased enothelin-1, deregulation of nitric oxide-mediated vasodilation, and increased platelet activation (32). Additionally, rhabdomyolysis was present in many cases and occurs due to direct cocaine-induced myocyte damage and vasoconstriction which decreases muscle perfusion (33). This leads to the release of myoglobin which is subsequently eliminated by the kidneys, where it may become concentrated and cause vasoconstriction, the production of free radicals, acute tubular necrosis, direct heme cytotoxicity and Tamm Horsfall protein precipitation. The result is distal tubular obstruction, with endothelin receptor activation which ultimately causes AKI (32,34,35). Other injury mechanisms include thrombotic microangiopathy, renal infarcts, acute interstitial nephritis and vasculitis caused by levamisole, an anthelmintic and immunomodulator used to increase the volume of cocaine (32).

A reasonable interpretation for the high prevalence of AKI and rhabdomyolysis is the presence of secondary kidney damage, and if this is the case, CPK might need to be examined closely to instate early recognition and intervention with simple measures like IV fluid hydration at a rate of 1.5 L/h or until a urinary volume of 200 cc/h is achieved (36,37). Its prognostic value may be delved into more with new prospective studies.

Liver damage had a prevalence of 8.8% in our population,

Table 3. *Comparison of acute kidney injury and acute liver failure cases in 159 patients with cocaine intoxication who consulted in an emergency room in Colombia. ación de los casos de lesión renal aguda e insuficiencia hepática aguda en 159 pacientes con intoxicación por cocaína que consultaron en un servicio de urgencias de Colombia.*

Variables	Acute kidney injury			Acute liver failure		
	Present (n=47)	Absent (n=112)	P value*	Present (n=14)	Absent (n=145)	P value *
Age in years	32 (24-39)	30 (22-38)	0.152	31 (26-37)	30 (22-38)	0.83
Male sex, n (%)	45 (95.7%)	87 (77.7%)	0.0049	13 (92.8%)	119 (82.1%)	0.467
Laboratory tests, Me (IQR)						
Sodium, mmol/L	141 (138-143)	140 (138-142)	0.392	142 (138-145)	140 (138-142)	0.110
Potassium, mmol/L	3.9 (3.7-4.3)	4 (3.7-4.3)	0.868	3.9 (3.8-4.2)	4 (3.7-4.3)	0.522
Magnesium, mmol/L	2.4 (2.2-3.3)	2.2 (1.9-2.3)	0.0001	2.7 (1.7-4.7)	2.2 (1.9-2.4)	0.098
pH	7.32 (7.23-7.38)	7.36 (7.31-7.42)	0.070	7.31 (7.20-7.35)	7.36 (7.31-7.42)	0.08
Bicarbonate, mmol/L	17.6 (12.4-22)	21 (20-23)	0.004	12.5 (11-19)	21.3 (19.4-22.4)	0.0016
INR	1.1 (1.02-1.14)	1.05 (1.01-1.14)	0.300	1.1 (1.07-1.4)	1.0 (1.07-1.1)	0.034
AST, U/L	48 (27-98)	30 (22-44)	0.0002	185 (123-542)	29 (23-44)	0.0000
ALT, U/L	31 (22-43)	24 (17-35)	0.020	105 (48-376)	23 (17-32.5)	<0.0001
Total bilirubin, mg/dL	0.70 (0.5-1.1)	0.63 (0.4-1)	0.234	0.5 (0.43-0.7)	0.8 (0.5-1)	0.40
Creatinine, mg/dL	2.1 (1.08-2.64)	1.0 (0.84-1.27)	<0.0001	1.92 (1.54-3.07)	1.0 (0.84-1.22)	0.0002
Peak creatinine	1.5 (1.2-2.0)	0.92 (0.8-1.1)	<0.0001	2.5 (1.54-5.46)	1.02 (0.84-1.27)	0.0003
CPK, U/L	2,006 (641-6,648)	469 (207-1,480)	0.0001	18,175 (4,758-44,182)	657 (273-1,828)	<0.0001
Peak CPK	2,006 (641-6,648)	469(207-1,480)	0.0001	18,175 (4,758-44,182)	658 (274-1,829)	<0.0001

Abbreviations: Me: median; IQR: interquartile range, INR: international normalized ratio AST: Aspartate aminotransferase, ALT: Alanine aminotransferase, Cr: creatinine, CPK: creatine phosphokinase.
* Corresponds to hypothesis tests using Fisher's exact tests for proportions or the Mann-Whitney U test for comparing the medians from two independent samples.

lower than what other authors have reported. Silva's study (38) estimated a prevalence of 59%, a difference possibly explained by the fact that all of those included in that study had concomitant rhabdomyolysis, and it covered a longer period of time (eight years). Liver damage occurs in these patients because once the norcocaine metabolite is produced by CYP2E1 and CYP2A, it is transformed into norcocaine nitroxide, N-hydroxynorcocaine and nitrosonium ion, which produce free radicals that cause oxidative stress and lipid peroxidation. Other proposed mechanisms are hypoxia, shock, and hyperthermia (39-41). AST is known to be found in the cytosol and mitochondria of various organs such as the liver, kidneys, heart tissue, skeletal muscle, brain, and pancreas, among others, and therefore is considered to be less specific for liver damage. On the other hand, ALT is present in the cytosol, mainly in the liver, with concentrations 10 times greater than those in skeletal muscle, but muscle has more mass than the liver, which helps explain why both AST and ALT are elevated in rhabdomyolysis. It is important to remember that elevated liver transaminases are generally accompanied by abnormalities in other tests such as INR (42), which was not our case, as the medians were similar between the groups of complications.

Of the patients with elevated liver function tests (a total of 14), 10 had some degree of AKI, and of the nine with ALT greater than 1,000, eight had AKI. Therefore, we believe there may be a common pathophysiological factor in the two lesions, such as rhabdomyolysis, since all the patients with AKI and elevated ALT had CPK levels greater than 1,000, which would add to the sympathetic activation, catecholamine reuptake inhibition, dehydration and vascular involvement. This finding has also been reported by other investigators who describe the concomitant presence of kidney and liver damage and rhabdomyolysis. A study carried out in Miami found 39 patients with cocaine use and rhabdomyolysis, of whom 33% had kidney failure and 11 patients had elevated transaminases (43). Akmal et al. (44) found elevated transaminases in patients with rhabdomyolysis, which reached higher levels if the patients had AKI. This seems to be explained by other little-studied mechanisms of injury such as those resulting from rhabdomyolysis, which include increased serum proteolytic activity due to enzyme release from injured myocytes which cause damage in different cells.

Rhabdomyolysis was a common finding, as out of 98 patients from whom CPK levels were drawn, 77 had values over 200 U/L and 47 had levels greater than 1,000 U/L, reaching a maximum level of 657,625 U/L. This could be explained by cocaine's effect on the mitochondria which causes Complex I and III dysfunction in the respiratory chain and increases the production of superoxide radicals (O_2^-) (45). Coupled with this are direct sarcolemma injuries and the lack of energy in the myocytes, which causes sodium-potassium

ATPase pump and sodium-calcium exchanger dysfunction, resulting in increased free intracellular calcium which activates the calcium-dependent proteases and phospholipases that cause myofibrillar destruction (46).

Other complications were found less frequently during the observation period. Acute myocardial infarction had a prevalence of 4.4%, but it is one of the most frequently reported complications of cocaine use. Most were males with a median age of 45 years, similar to other studies which report an age range of 34±7 years (47). The risk of AMI is explained by the sympathomimetic effect which increases peripheral vasoconstriction, chronotropism and inotropism, nitric oxide synthase block and increased entothelin-1 which cause increased blood pressure. This is coupled with coronary vasospasm, increased myocardial oxygen demand, a prothrombotic state with increased von Willebrand factor, an abnormal response to acetylcholine-induced vasodilation and accelerated coronary atherosclerosis (48-50). Although the risk of AMI increases with the concomitant use of alcohol, no blood alcohol levels were found in the cases we described.

Regarding CVA, with a prevalence of 4.4%, most of our findings are similar to those of other studies in which most cases are ischemic (51). However, the prevalence in other studies may be even greater as reported in Baltimore (Washington), which was 9.7% (52), a fact which may be explained by the sample size. The risk of CVA seems to be greater in the first 24 hours after drug use and is related to the increased sympathetic tone which favors hypertension and vasoconstriction (53).

Understanding toxicosurveillance to be an active process in which the risks of a specific toxin are identified and evaluated and measures are taken to reduce them (54), we can say that, in our case, to decrease the risk of acute cocaine toxicity, measures must be taken by governmental entities to eliminate illegal crops, and create and direct strategies for the prevention of drug use beginning in childhood, especially in low-income areas and communities with school desertion, where the most vulnerable people are found. Within hospitals, organ damage markers should be identified and actively sought in the emergency room through the physical exam and laboratory tests, to provide a complete assessment of all the organs and an early start to treatment.

A few limitations should be pointed out, which support the exploratory nature of the descriptions provided. On the one hand, the sample size was relatively small, partly due to a restricted definition of cocaine intoxication in an effort to control confounding through the selection of participants. Furthermore, there is a high risk of measurement bias because the assessment of each variable was based on the clinical judgement of the attending physicians.

Conclusions

Acute cocaine intoxication may lead to multiple organ abnormalities, especially kidney and liver disorders, which may be related to direct injury. However, the significant CPK elevation found suggests muscle damage which may cause these disorders or contribute to them. This may indicate the need for strict surveillance of this enzyme to allow early and simple interventions like venous hydration, and the performance of longitudinal research studies to determine its value as a prognostic marker.

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