Intracranial Bleed Caused by Acute Methamphetamine Use

Moyra N. Rasheed, MD

A 30-year-old homeless man was brought to the emergency department (ED) secondary to altered mental status, confusion, and agitation.

History

Upon presentation, the patient reported consuming alcohol and occasionally using recreational drugs. The most recent occurrence of recreational drug use was the day prior to presentation, during which he had used intravenous (IV) methamphetamine.

His medical history was significant for seizures over the previous several years, for which he was prescribed levetiracetam. However, he had not taken the medication for several months. Because the patient had relocated from another state a year earlier, a deeper medical history regarding his seizures or hospitalization records could not be obtained.

Physical examination

During the history-taking process, the patient was agitated and mildly confused. He attempted to get out of bed several times and mentioned a "beach that I visited yesterday, where I swam with mermaids." He was alert and oriented to person but not to time or place. Results of a neurological examination were significant for abnormal cognitive status, and he could only follow some commands.

The results of a physical examination were significant for hypertension with a blood pressure of 180/90 mm Hg, an elevated heart rate of 110 beats/min, an elevated respiratory rate of 22 breaths/min, and a fever of 37.7 °C. The patient's heart and lung sounds were normal, and results of a gastrointestinal examination were unremarkable. Linear track marks from prior recreational drug use were noted on both arms.

Diagnostic testing

Causes for the patient's impaired cognitive function and agitation were sought. His initial diagnosis was thought to be due to polysubstance misuse. There was a main concern for underlying adverse effects from methamphetamine, as well as alcohol intoxication, aspiration pneumonia, and seizures associated with a postictal state.

Initial routine laboratory results were significant for an elevated level of white blood cells at 15 cells/μL, elevated levels of aspartate aminotransferase (55 U/L) and alanine aminotransferase (64 U/L), and a low level of lactic acid at 3 mg/dL. Levels of platelets, hemoglobin, and blood glucose were within the normal limits.

Results of a chest radiography scan showed mild atelectasis and an infiltrate at the left base. Results of an electrocardiography scan confirmed minimal ST segment depression in leads 2, 3, and Avf with a QTc interval of 445 ms.

Empirical treatment with IV levetiracetam; IV lorazepam, 2 mg; and piperacillin/tazobactam were initiated for suspected pneumonia. A Clinical Institute Withdrawal Assessment for Alcohol was administered, and blood cultures and troponin levels were examined. After the tests were conducted and medications were administered, the patient was admitted to the hospital.

Within a few hours in the ED prior to transferring to the inpatient ward, the patient became more withdrawn and was found gazing into space with drooling, despite supportive treatment. He was no longer able to communicate. A stat computed tomography (CT) scan of the head was conducted, results of which showed a left temporal and frontal temporal intraparenchymal bleed measuring 6.3 cm with surrounding edema and a 6-mm left to right midline shift (Figure 1). Findings were confirmed with a magnetic resonance imaging (MRI) scan of the head (Figure 2). A CT angiography scan of the

AFFILIATIONS:
Internal Medicine Department, John Muir Medical Center, Concord, California

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CORRESPONDENCE:
Moyra N. Rasheed, MD, John Muir Medical Center, 2700 Grant Street, Suite 200, Concord, CA 94520 (moyrarasheed39@yahoo.com)

head ruled out anatomical anomalies including aneurysms, although it did show vasospasm of the cerebral vessels.

Within the next few hours, the patient was unable to support his own airway and was intubated in the setting of hypercapnic hypoxic respiratory acidosis. He was found to have Klebsiella pneumoniae, which developed into acute respiratory distress syndrome. Over the next 3 days, he developed multiorgan failure with septic shock.

His laboratory results were consistent with disseminated intravascular coagulation, acute renal failure from hypotension and sepsis, liver shock, and cardiogenic shock. Results of an echocardiography scan showed a hypokinetic left ventricle with an ejection fraction of less than 20%.

Treatment

In the neurology critical care unit, the patient was seen by the neurointensivist and neurosurgeon. The patient was deemed a poor candidate for further surgical intervention given the large cranial bleed and multiorgan failure. The patient was then started on multiple pressors including vasopressin, phenylephrine, dopamine, epinephrine, and norepinephrine in a span of less than 2 days. He required multiple ampules of bicarbonate and nitric oxide, although little improvement in his acidotic state was seen. He was then started on continuous renal replacement therapy, but little improvement was seen. Cefepime was initiated, but the patient's lactic acidosis and respiratory status did not improve.

Extracorporeal membrane oxygenation was considered, but given the patient's underlying bleed and disseminated intravascular coagulation, the decision to initiate this treatment was deferred. The patient continued to decline despite intensive care support.

Discussion

Methamphetamine is a sympathomimetic amine, which has stimulant, euphoric, and hallucinogenic effects. From 2015 to 2018, an estimated 1.6 million US adults had reported annual methamphetamine use, and 22.3% had reported injecting methamphetamine within the past year.[1] A total of 52.9% had a methamphetamine use disorder.[1] Methamphetamine has increased lipophilicity, which enables it to easily pass through the blood-brain barrier. It is an indirect neurotransmitter that embeds itself into cytoplasmic vesicles where it displaces epinephrine, norepinephrine, dopamine, and serotonin into the cytosol. As these concentrations rise within the cell, the neurotransmitters diffuse out of the neuron and synapse with the postsynaptic receptors, resulting in a surge of adrenergic stimulation. These stimulated adrenergic receptors cause hypertension, tachycardia, hyperthermia, and vasospasm, which may be hard to differentiate from more-critical complications that methamphetamine can cause.[2,3]

When our patient first presented, most of his symptoms were consistent with the acute effects from methamphetamine use. He also had methamphetamine-related complications—including an intracranial hemorrhage, which was overlooked on his initial admission—in addition to having the stimulating effects of methamphetamine.

Methamphetamine, cocaine, and ecstasy are known as "designer drugs." They are quickly replacing traditional causes of intracranial hemorrhage in young adults. These hemorrhages occur because of uncontrolled hypertension, vasospasm, and in some cases—especially with methamphetamine and cocaine use—underlying vascular malformations like aneurysms. Therefore, a CT scan of the head should be part of the workup in young adults with methamphetamine use and behavioral changes.[4-6]

The onset of action occurs within seconds after smoking or injecting the drug, and its peak plasma concentrations are reached 30 minutes after IV or intramuscular administration and up to 2 to 3 hours after ingestion. The plasma half-life is 12 to 34 hours, although the duration can persist longer when renal or hepatic insufficiency is present or in individuals with binge use, given that the breakdown of methamphetamine results in active metabolites that can stack in the system.[2,7]

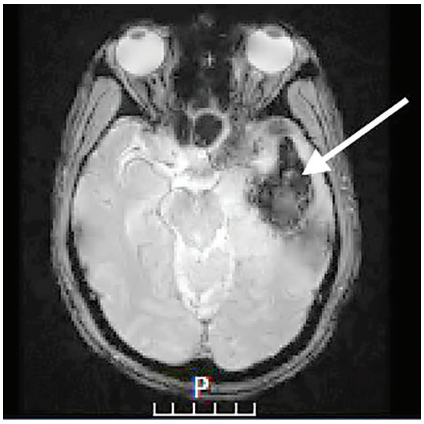

Figure 1. Results of a stat CT scan of the head showed a left temporal and frontal temporal intraparenchymal bleed with surrounding edema and a left to right midline shift.

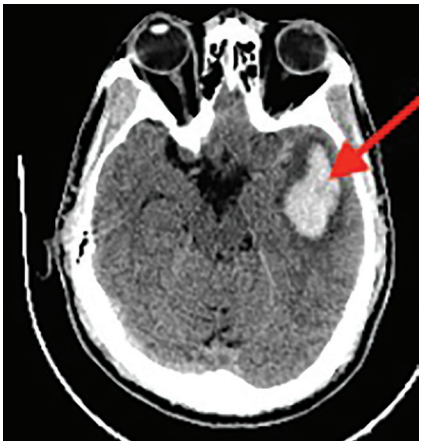

Figure 2. Results of an MRI scan of the head confirmed the findings from the CT scan.

Conclusion

From a neurological standpoint, acute methamphetamine use can cause agitation, delirium, and paranoia. However, cerebrovascular disorders contribute to morbidity, disability, and fatality associated with illicit drug use and should not be missed. A fatal complication from using methamphetamine or other designer drugs are brain bleeds, including intracranial hemorrhage, subarachnoid

hemorrhage, and subdural hemorrhage, as well as underlying ischemia resulting in stroke.[4,8,9]

In the past, these sequalae were thought to be solely caused by uncontrolled hypertension and vasospasm, as in our patient's case. We now know that many patients have vascular anomalies as well. Illicitly misused neurostimulants predispose patients to aneurysmal formation with reported rupture at a younger age and with much smaller sized aneurysms.[4] Therefore, in addition to conducting a CT scan of the head to rule in brain bleed, patients should also undergo a CT angiography scan if a bleed is found on the CT scan.

Causes of intracranial bleeds include disruption to the blood-brain barrier, changes in cerebral perfusion representing neural toxicity from excess neurotransmitters in the brain, and depletion of dopamine and serotonin; in chronic users, cortical grey and white matter loss is also seen.[3,10]

Patient outcome

After the patient's underlying CT scan findings were evaluated, he required ventilation support and multiple pressors, antibiotics, and continuous renal replacement therapy. It is not clear why our patient deteriorated rapidly to multiorgan failure. There may be a combined cause from underlying methamphetamine use and the pathological changes that occur including vasospasm, increased sympathetic activity, and changes in neurological state in the setting of an influx of neurotransmitters in addition to the burden from the large intracranial bleed.

Four days after he was admitted to the hospital, the patient had a cardiac arrest with underlying asystole. Given that he was still intubated, taking multiple pressors, and on a bicarbonate drip, further resuscitation measures seemed futile. The patient died in the intensive care unit 4 days after admission in the setting of intracranial hemorrhage, respiratory failure, and multiorgan failure.

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