Diabetic Ketoacidosis Causing Transient Homonymous Hemianopia and Generalized Seizure: A Case Report and Literature Review

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ABSTRACT

Introduction: Neurologic complications of hyperglycemia are common. Cases of seizures and hemianopia related to nonketotic hyperglycemia have been reported but are rare with diabetic ketoacidosis.

Case Presentation: We present clinical, laboratory, and radiologic findings in a patient with diabetic ketoacidosis associated with generalized seizure and homonymous hemianopia, with a literature review of reported cases.

Discussion: Neurologic complications of hyperglycemia are many, but seizure with hemianopia is most commonly associated with nonketotic hyperosmolar hyperglycemia rather than diabetic ketoacidosis.

Conclusions: Generalized seizure and retrochiasmal visual field defect are known neurological complications of diabetic ketoacidosis. Like nonketotic hyperosmolar hyperglycemia, these neurological symptoms are transient, and the structural changes in magnetic resonance imaging are usually reversible.

INTRODUCTION

Diabetic ketoacidosis (DKA) and nonketotic hyperosmolar hyperglycemia (NKHH) are major life-threatening complications of diabetes. DKA usually evolves over 24 hours. Common precipitating factors include inadequate administration of insulin, infections (including pneumonia, sepsis, or urinary tract infections), cerebral or coronary infarction, and pancreatitis. Patients present with multiple systemic symptoms, including nausea, vomiting, and abdominal pain. In DKA, glucose can range from 250-600 mg/dl, osmolality 300-320 mosm/kg, serum beta-hydroxybutyrate elevation (>2.5 mmol/L), decreased serum bicarbonate (<18 meq/L), and arterial pH (6.8–7.3) with elevated anion gap and urine ketones. In contrast, patients with NKHH present with several weeks of polyuria, weight loss, and varying degrees of altered level of consciousness. Precipitating factors are similar to DKA. They have marked hyperglycemia (600 – 1200 mg/dl), elevated osmolality (330-380 mosm/kg), decreased serum beta-hydroxybutyrate (<1.0 mmol/L), elevated serum bicarbonate (>18 meq/L), elevated arterial pH (>7.3) with normal anion gap and absent or trace urine ketones.

Both DKA and NKHH are characterized by intracellular dehydration and occur when the level of insulin is not sufficient to support transmembrane transport of adequate glucose into cells. In the case of DKA, the liver rapidly breaks down fat into ketones to employ as a fuel source. The overproduction of ketones ensues, causing them to accumulate in the blood and urine. For NKHH, the level of insulin is usually sufficient to inhibit free fatty acid mobilization, leading to little or no ketone accumulation in the blood or urine.

Neurologic complications of hyperglycemia are diverse, including choreoathetosis, hemiballism, dysphagia, seizures, and coma. Various types of seizures (occipital, focal, or complex partial) and hemianopia in the setting of NKHH have been reported.[1-12] We report the case of DKA complicated by homonymous hemianopia and generalized seizure, with a literature review.

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Table 1. Demographic, Clinical, Laboratory, Radiologic, and Electroencephalogram (EEG) Features of Cases

	Case Review	Present Case
Demographics		
Age at presentation, Mean (+/- SD); n = 24	53.0 (13.01)	38
Age at presentation, Median (Range); n = 24	53.5 (30.0-83.0)	
Sex, N = 24		
Male n (%)	16 (66.7)	Male
Female n (%)	8 (33.3)	
Known diabetic at presentation	11 (45.8)	Yes
Clinical Features		
Presenting symptoms		
[a]Occipital seizures n (%), N = 23	18 (78.3)	
Headache n (%), N = 24	5 (20.8)	
[b]Focal motor seizure n (%), N = 24	7 (29.2)	
[c]Generalized seizure n (%), N = 24	2 (8.3)	Yes
Neurologic examination findings		
Hemianopsia, n (%), N = 24	22 (91.7)	
Clinical seizure, n (%), N = 24 (focal, generalized, oroccipital)	24 (100)	
Laboratory findings at presentation		
Serum glucose mg/dl, mean (+/- SD), n = 24	472.1 (166.85)	487
Serum glucose mg/dl, median (range), n = 24	460.5 (261.0-999.0)	
Serum osmolality mOsmo/kg, mean (+/- SD), n = 20	297.1 (39.54)	321
Serum osmolality mosm/kg, median (range); n = 20	304.5 (136.0-333.0)	
Hemoglobin A1C %, mean (+/- SD), n = 10	13.1 (2.37)	16.5
Hemoglobin A1C %, median (range), n = 10	13.5 (9.4-17.8)	
Urine ketone present, n (%); N = 14	2 (14.3)	Yes
Beta-hydroxybutyrate mmol/l, mean (+/- SD), n = 24 (None reported in case review)	—	4.8
EEG findings, N = 23		
Interictal epileptiform discharge, n (%)	15 (65.2)	No
Nonspecific slowing, n (%)	4 (17.4)	Yes
Normal n (%)	4 (17.4)	No
MRI findings, N = 21		
T2/FLAIR hypointensity, n (%)	15 (71.4)	Yes
T2/FLAIR hyperintensity, n (%)	5 (23.8)	No
Restricted diffusion signal abnormality, n (%)	8 (38.1)	No
Enhancement on brain MRI n (%), N = 18	5 (27.8)	No
Normal, n (%), N = 22	3 (13.6)	No
Outcome at discharge/follow-up evaluation (2 days to 6 months), N = 24		
Clinical findings (seizure/hemianopia) resolved, n (%)	24 (100)	Yes
MRI findings resolved, n (%), N = 16	11 (68.8)	Yes
MRI findings incompletely resolved, n (%), N = 16	5 (31.2)	—
EEG findings completely resolved, n (%), N = 15	15 (100)	—

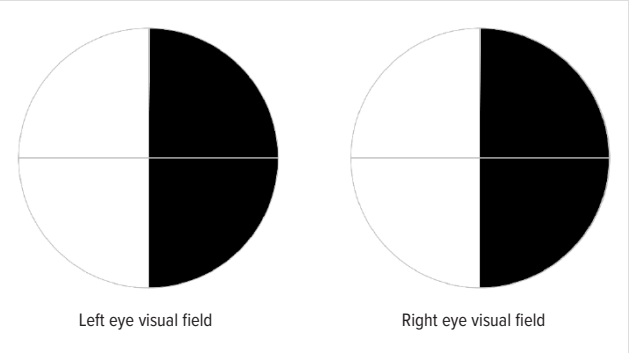
Abbreviations: MRI, magnetic resonance imaging; FLAIR, fluid-attenuated inversion recovery.

[a]Occipital seizure: Visual hallucinations characterized by flickering colored geometric designs or lights with or without blurry vision, generally lasting less than 1 minute for each occurrence.

[b]Focal seizure: Rhythmic jerking of 1 limb with preserved consciousness, lasting less than 5 minutes.

[c]Generalized seizure: Tonic-clonic limb movement of the upper and lower extremity with altered alertness, lasting 1-2 minutes, followed by postictal confusion and tiredness.

Figure 1. Visual Field Testing Showing a Right Homonymous Hemianopia



CASE PRESENTATION

A 38-year-old man had 2 weeks symptoms of progressive right visual loss and intermittent headache. He was bumping into objects in his right visual field. His past medical history included poorly controlled type 2 diabetes and hypertension.

On admission, he was afebrile, blood pressure was 144/95 mmHg, and neurologic examination showed dense right homonymous hemianopia. The hemianopia finding was confirmed by Ophthalmology and Neurology (Figure 1). Laboratory studies (Table 1) showed serum glucose of 487 mg/dl; bicarbonate of 14 mmol/l; serum osmolality of 321 mosm/kg; elevated anion gap, hemoglobin A_{1c}, and beta-hydroxybutyrate of 25, 16.5%, and 4.8 mmol/l, respectively. Spot urine analysis showed glycosuria (>1000 mg/dl) and ketonuria (>150 mg/dl). Significant improvement of all laboratory studies on hospital days 2 and 3 is demonstrated in Table 2. Brain magnetic resonance imaging (MRI) obtained on hospital day 2 showed T2/ fluid-attenuated inversion recovery (FLAIR) hypointense signal within the left parieto-occipital subcortical white matter (Figure 2A). There was no abnormality of the diffusion weighted imaging sequence (not shown). Computed tomography angiography of head and neck showed no flow-limiting stenosis.

The patient was started on intravenous (IV) hydration with normal saline and insulin. On hospital day 2, he had a witnessed stereotype generalized seizure of rhythmic tonic-clonic activity affecting both arms and legs with tonic upward eye deviation lasting 1 minute, followed by 45 minutes postictal drowsiness and confusion. He was treated with 2 mg of lorazepam intravenously once, followed by a loading dose of levetiracetam of 13.3 mg/kg and maintenance dose 500 mg orally twice daily. Electroencephalogram (EEG) obtained on the same day showed nonspecific slowing.

He was discharged on hospital day 4 with levetiracetam 500 mg twice daily and oral hypoglycemic agent. At neurologic follow-up evaluation 3 weeks later, he had complete resolution of his right homonymous hemianopia and abnormal brain MRI (Figure 2B), with no recurrent clinical seizure.

DISCUSSION

We present a unique case of ketotic hyperosmolar hyperglycemia complicated by generalized seizure and retrochiasmal visual field defect. None of the reported cases in our review had such a profound ketonuria (>150 mg/dl of urine ketone) or ketonemia (serum hydroxybutyrate 4.8 mmol/l). Our literature review identified 2 cases, one reporting trace ketonuria[1] and another high ketonuria.[13] The implication is that DKA can mimic NKHH neurologic complications.

Most of the patients with NKHH in our case review presented with occipital seizure (78.3%) and focal seizures (29.2%),[1-5, 7-12] while the minority presented with generalized seizure,[4,6] as was seen in our case. Brain imaging findings of reversible T2/FLAIR hypointensity, clinical symptom response to treatment with triple therapy (IV saline hydration, insulin, and antiepileptic drug), serum osmolality, and glucose levels above 300 mosm/kg and 400 mg/dl, respectively, seen in our case were similar to those in the literature review.

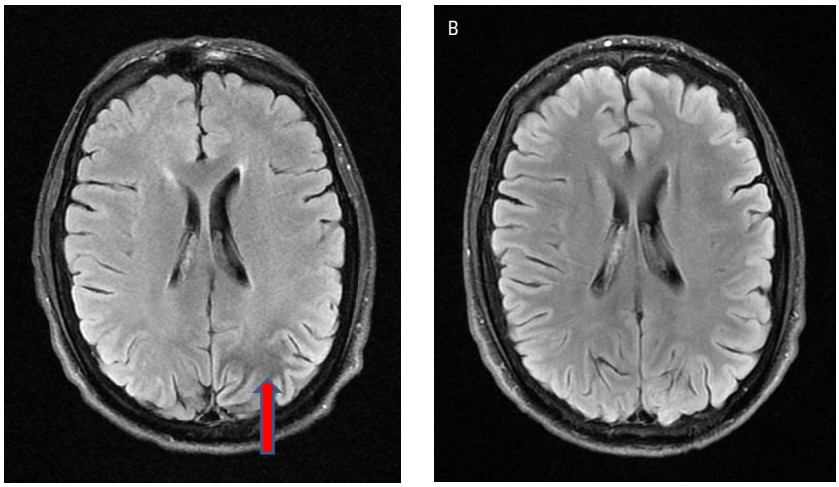
Interestingly, follow-up brain MRI findings of persistent abnormality involved restricted diffusion signal changes not seen in our patient. Restricted diffusion signal abnormality is in keeping with cytotoxic injury typically seen with ischemic infarct, while T2/FLAIR hypointense abnormality may be due transient deposition of free radicals and/or iron that resulted from excitatory axonal damage during hyperglycemia-induced seizures and intracellular dehydration in glial and supporting tissues.[14] EEGs were performed in 23 of the 24 cases in the literature, with 65.2% showing interictal epileptiform discharges. The minority (17.4%)—as in our case—showed nonspecific diffuse slowing.

The mechanism of cerebral injury from hyperglycemia is unclear. Many hypotheses have been proposed, including neuronal dysfunction due to intracellular dehydration and end-organ iron deposition;[14-15] autoregulation failure due to sympathetic dysautonomia, endothelial dysfunction, blood brain barrier breakdown, and free radical release;[16] and depletion of gamma aminobutyric acid due to alteration in Krebs cycle with resulting depressed glucose utilization during hyperglycemic conditions.[17]

CONCLUSIONS

Homonymous hemianopia and seizures are established complications of NKHH but rarely are reported in DKA. Both conditions, although different in many ways, have similar underlying hyperosmolar hyperglycemic states that may result in comparable neurological complications.

Figure 2. Magnetic Resonance Imaging (MRI) of the Brain



A. Brain MRI on hospital day 2, showed fluid attenuated inversion recovery (FLAIR) hypointensity in the left occipital lobe (red arrow).

B. Brain MRI 3 weeks after onset of symptoms showed complete resolution of the previous abnormality (Figure 2A) in the left occipital lobe.

Table 2. Comparison of Laboratory Data Hospital Days 1-3

Lab Parameters	Day 1[a]	Day 2	Day 3
Glucose (POC), mg/dl			
Mean	487	201.2 (n = 10)	185.8 (n = 13)
Median (Range)	—	179.0 (137-317)	163.0 (108-302)
Sodium, mmol/L	130	136	138
Chloride, mmol/L	91	105	104
Bicarbonate, mmol/L	14	20	24
Anion gap	25	11	10
Potassium, mmol/L	4.3	3.7	4.0
Osmolality mOsm/kg	321	ND	ND
HbA1c, %	16.5	ND	ND

Abbreviations: HbA1C, hemoglobin A1c; ND, not done.

[a]Admission day.

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