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Seizures as Complications in Diabetic Ketoacidosis: A Case Report

Gabriella Agatha [1], Agus Yudho [2]
[1,2] Department of Internal Medicine, Siloam Hospital Jember, Jember, Indonesia
[*] Correspondence author: gabyshawol20@gmail.com

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ABSTRACT

Diabetic ketoacidosis (DKA) is a significant metabolic consequence of diabetes mellitus (DM). Generalized seizures in association with DKA were typically observed in young patients with diabetes mellitus type 1 (DMT1) and less frequently reported in adults with diabetes mellitus type 2 (DMT2).

We present the case of a 48-year-old man who experienced a generalized seizure and was brought to the emergency department. Examination results revealed hyponatremia, severe hyperglycemia, leukocytosis, and metabolic acidosis. The patient was treated with fluid rehydration, a continuous insulin regimen for blood sugar control, antibiotics, management of hyponatremia, and antiepileptic medication. The patient recovered from DKA and remained seizure-free after that.

Management of DKA with seizures involves fluid rehydration, infection management, and blood sugar correction using insulin. Antiepileptic drugs can be administered for initial seizure management and as maintenance therapy to prevent recurrent seizures.

Rehydrating, treating hyperglycemia, and giving antiepileptic medicine are all effective ways to manage DKA with concurrent seizures. This case is a testament to successfully managing such a complex condition.

Keywords: Diabetic Ketoacidosis, Diabetes Mellitus, Hyperglycemia, Seizures, Case Report

1. Introduction

Diabetic ketoacidosis (DKA) is a severe metabolic complication of diabetes mellitus (DM). DKA arises from an absolute or relative insulin deficiency and elevated counter-regulatory hormone levels. [1] DKA is more commonly experienced by patients with type 1 diabetes (two-thirds) compared to type 2 diabetes (one-third). DKA often appears as an early manifestation of type 1 diabetes. In DMT2, DKA occurs in patients with poor medication adherence. [2]

The incidence rate of DKA varies widely across populations, with reports ranging from 0 to 56 per 1,000 people annually. Sweden and Finland had the most significant incidences, 41 and 37.4 per 100,000 years, respectively. Epidemiological statistics on the frequency of DKA occurrences in Indonesia are currently unavailable. Several retrospective studies conducted in various tertiary hospitals in Indonesia, such as Cipto Mangunkusumo Hospital and dr Soetomo Hospital, have shown a persistently high DKA mortality rate, similar to trends observed in other developing countries.[3] Death in this condition is rare due to ketoacidosis and hyperglycemia alone, but rather because of the underlying disease.[2]

Seizures in cases of DKA are more frequently reported in DKA patients with type 1 diabetes and are more common in children. We present a case of an adult type 2 diabetic patient with DKA who exhibited seizures early in the condition.

2. Case

A 48-year-old man arrived at the emergency department (ED) after experiencing three episodes of tonic-clonic seizures, which lasted 15 minutes and affected his entire body. He regained consciousness between episodes. The patient had two further seizures while in the emergency department. Along with seizures, the patient also had nausea and vomiting. The patient received airway, breathing, and circulation stabilization, followed by an intravenous (IV) infusion of 0.9% sodium chloride. To manage the seizures, he was administered 5 mg of diazepam IV, followed by a loading dose of 900 mg phenytoin over 15 minutes due to recurrent seizures. The patient received 1000 cc of 0.9% sodium chloride for rehydration, 8 mg of ondansetron, and 40 mg of esomeprazole. The seizures have stopped.

The patient had a history of uncontrolled DMT2 due to poor medication adherence, leading to complications such as a chronic, non-healing ulcer on his leg. His prescribed regimen included 35 units of short-acting insulin once daily and dapagliflozin once daily Upon assessment, the patient's respiration rate was 24 breaths per minute, and his blood pressure was elevated at 172/95 mmHg. The rest of his medical evaluation, including the neurological assessment, was normal. Laboratory results showed severe hyperglycemia, with a blood glucose level of 963 mg/dL. Arterial blood gas analysis revealed a pH of 7.1 (normal 7.35-7.45), pO2 of 84.4 mmHg, pCO2 of 34.8 mmHg, HCO3 of 10.3 mmol/L, and a base excess of -18.1, all indicating moderate metabolic acidosis. Electrolyte examination revealed hyponatremia (126 mmol/L sodium), hypokalemia (3.3 mmol/L potassium), and normal chloride levels (101 mmol/L). The total blood count showed leukocytosis, with a white blood cell count of 20,830/µL and increased platelets of 617,000/µL.

The patient was admitted to the intensive care unit (ICU) for continued fluid rehydration, rapid insulin therapy, and electrolyte correction. He was provided with comprehensive management between internal medicine and neurology. He got a continuous insulin infusion with dose changes based on blood sugar levels, as well as maintenance IV phenytoin (100 mg every 12 hours) to prevent recurrent seizures. Broad-spectrum antibiotic therapy was initiated with meropenem (1 g every 8 hours), and electrolyte imbalances were corrected with 3%

sodium chloride (500 cc/24 hours). On the second day in the ICU, hypokalemia (potassium 2.7 mmol/L) was treated with potassium chloride 50 mEq. The patient was additionally given 25% albumin due to an albumin level of 2.47. On the second ICU day, a head CT scan revealed a subacute lacunar infarct in the left posterior limb of the internal capsule. (Figure 1). For the management of ischemic stroke, conservative treatment is carried out.

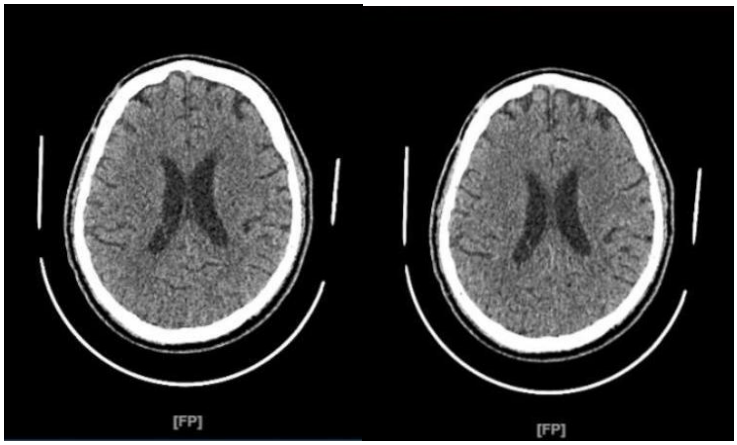

Figure 1. CT head of the patient that showed subacute lacunar infarct in the left posterior limb of the internal capsule

After 3 days of treatment, the patient was transferred to a low-care room, and blood sugar was controlled below 200 mg/dL. The patient did not experience further seizures during his ICU and low care room. On the sixth day, laboratory results indicated leukocytes at 10,300/µL and a random blood sugar level of 189 mg/dL. He was discharged with controlled blood glucose and resolved infection and electrolyte levels. Discharge medications included cefixime (100 mg every 12 hours), phenytoin (100 mg every 12 hours), and short-acting insulin (30 units every 12 hours).

During his outpatient follow-up one week after discharge, the patient's random blood sugar was 207 mg/dL. After one month, his blood sugar was consistently controlled, allowing for the discontinuation of antiepileptic medication after two months. The patient reports being free of seizure episodes and has no neurological deficits. attends regular monthly outpatient visits to manage his diabetes. He has been educated on proper blood sugar management and adherence to medication.

3. Discussion

DKA remains a common occurrence in Indonesia, especially among patients with DMT2, who often face challenges with medication adherence. In this case, the patient's poor medication adherence, along with the infection process and an ischemic stroke, were identified as key triggers for DKA. Cerebrovascular abnormalities contribute to an increase in stress hormones that trigger DKA. Additionally, DKA can contribute to cerebrovascular events due to vascular anomalies, systemic inflammation, and a heightened risk of coagulopathy. [4]

Seizures are uncommon in DKA and are more frequently reported in cases of Hyperglycemic Hyperosmolar Syndrome (HHS). [5] Many factors, such as cerebral edema, cerebral venous sinus thrombosis, previous epilepsy, and a lowered seizure threshold, can cause seizures in patients with DKA. [6]. In this patient, features of both DKA and HHS were observed, with severe hyperglycemia (initial blood glucose of 963 mg/dL) and metabolic acidosis with an anion gap. These mixed features could account for the occurrence of seizures, as HHS can predispose patients to seizures through mechanisms that are not fully understood.

One theory suggests that in hyperosmolar hyperglycemic conditions, there is a decrease in gamma-aminobutyric acid (GABA) due to the suppression of glucose utilization and the Krebs cycle. This decrease in GABA levels is suspected to lower the seizure threshold, thereby increasing the likelihood of seizures.[7]

The primary management goals for DKA include fluid rehydration, insulin administration, potassium monitoring, and addressing precipitating factors. [1] Initial rehydration with 0.9% sodium chloride (15-20 ml/kg per hour for the first hour) improves tissue perfusion, corrects electrolyte imbalances, and helps lower blood glucose and counter-regulatory hormone levels. Careful monitoring of infusion rates is crucial to avoid cerebral edema. Insulin therapy, initiated at 0.1 unit/kg per hour IV, suppresses ketogenesis, lipolysis, and endogenous glucose production and is titrated to maintain blood glucose levels around 200 mg/dL. Once glucose falls below this threshold, insulin is reduced by half, and a D5% infusion is introduced to prevent hypoglycemia. Potassium levels should be closely monitored due to insulin's effect of shifting potassium into cells; if potassium is <3 mEq/L, insulin administration should be delayed to avoid hypokalemia-related complications. Hypokalemia can worsen the condition of diabetic ketoacidosis (DKA) and cause arrhythmias, so potassium supplementation is recommended to maintain potassium levels at 4-5 meq/L. [8,9]

This patient's seizures are classified as acute symptomatic, where metabolic disturbances provoke the central nervous system to produce seizure activity. Factors such as extreme blood sugar fluctuations (<36 mg/dL or >450 mg/dL) and ketoacidosis are associated with an increased risk of seizures in diabetic patients.[10] The use of antiepileptic drugs for acute symptomatic seizures is recommended in acute conditions. However, long-term use as a seizure prevention therapy is not recommended. Current recommendations suggest using AEDs for no more than 7 days unless nerve damage is present, with a maximum of 3 months in cases of persistent risk.[11] A decrease in blood sugar levels plays a significant role in stopping seizures and preventing recurrent seizures. Blood sugar that is controlled with antidiabetic medication can prevent the occurrence of recurrent seizures even if antiepileptic drugs are discontinued. [12]

4. Conclusion

The management of DKA with concurrent seizures involves careful rehydration, correction of hyperglycemia, and short-term use of antiepileptic medications to control acute seizure activity. Achieving stable blood glucose levels is critical, as effective glycemic control significantly reduces the risk of seizure recurrence.

5. Conflict of Interest

There is no conflict of interest behind this study

6. References

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