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Serial Magnetic Resonance Imaging Findings in a Patient with Hyperglycemia-Related Osmotic Demyelination Syndrome: A Case Report

Jong Hyuk Kim, MD
Department of Radiology, Myongji Hospital, Hanyang University, College of Medicine
Noh Hyuck Park, MD (nhpark904@gmail.com)
Department of Radiology, Myongji Hospital, Hanyang University, College of Medicine

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Abstract

Background: The authors report serial magnetic resonance imaging findings of osmotic demyelination syndrome (ODS) related to hyperglycemia in a patient with uncontrolled diabetes mellitus.

Case presentation: A 61-year-old man with diabetes was admitted for general weakness and severe thirst. A few days later, he complained of dysarthria, dysphasia, and dysmetria. On admission, he exhibited significant hyperglycemia (33.5 mmol/L [627 mg/dL]), with a glycated hemoglobin level of 18.1%. Other laboratory investigations revealed a sodium level of 133 mEq/L, potassium 3.8 mEq/L, blood urea nitrogen 43.9 mg/dL, with a calculated serum osmolality of 324 mOsm/kg. Brain magnetic resonance imaging (MRI) revealed T2 signal abnormalities that were symmetrical, non-space occupying, and located in the central pons with a peripheral sparing pattern, which were findings suggestive of ODS. In addition, subsequent MRI revealed progression of signal hyperintensity; however, the patient's symptoms were improved and he was discharged after 2 months.

Conclusion: We report a rare case of hyperglycemia-related ODS that exhibited gradual progression in imaging features despite the prompt correction of blood sugar levels and improvement of neurological symptoms

Background

Osmotic demyelination syndrome (ODS) is a non-inflammatory demyelinating disease that occurs in a variety of clinical settings, but most commonly in association with a rapid rise in plasma osmolality during correction of chronic hyponatremia [1]. It has recently been reported that ODS can also occur in the context of a rapid increase serum osmolality in the absence of rapid changes in serum sodium levels [2].

In this article, we report a rare presentation of ODS that occurred secondary to a hyperglycemic hyperosmolar state (HHS) with normal corrected serum sodium levels.

Case Presentation

A 61-year-old man presented to the emergency department due to general weakness and severe thirst. He had a medical history significant for type II diabetes mellitus, hypertension, dementia, and liver cirrhosis. His compliance to medication was poor, especially prescribed insulin. The initial suspicion was HHS; therefore, he was admitted to correct hyperglycemia. In the following few days of hospitalization, he complained of progressive motor weakness and could not stand alone. Dysarthria, dysphasia, and dysmetria, which progressively worsened over the previous 10 days, also emerged despite adequate control of blood sugar levels.

A neurological examination was performed, and the patient was in an alert mental state. Eye movement abnormality with lateral gaze limitation was found. Motor power was grade 3 or 4 in all extremities, but sensation was intact. Gait evaluation was not performed because of the patient's bed-ridden status. General physical examination was unremarkable (regular heart sounds, clear breath sounds, and soft, non-tender abdomen with normal bowel sounds).

Laboratory investigations

On admission, significant hyperglycemia (33.5 mmol/L [627 mg/dL]) was noted, and glycated hemoglobin level was 18.1%. Other investigations revealed a sodium level of 133 mEq/L, potassium 3.8 mEq/L, blood urea nitrogen 43.9 mg/dL, with a calculated serum osmolality of 324 mOsm/kg. Plasma and urinary ketones were negative, and arterial blood gas analysis revealed a pH of 7.41.

Imaging findings

MRI was performed 8 days after admission; at that time, his neurological symptoms appeared. Prominent high signal intensity was observed within the pons on subsequent T2-weighted imaging. These signal abnormalities were symmetrical, non-space occupying, and located in the central pons with peripheral sparing pattern, which are findings suggestive of ODS. Diffusion-weighted imaging revealed subtle increased signal intensity in the pons without definite low apparent diffusion coefficient values, findings consistent with T2-shine-through (Fig 1). These signal abnormalities were also evident in the lower pons and periaqueductal area. The basal ganglia, thalami, and both cerebral hemispheres were within normal limits. No significant abnormalities were noted on magnetic resonance angiography.

Follow-up MRI performed 10 days later revealed a newly developed lesion in the posterior tegmentum portion of the upper pons and bilateral brachium pontis (Fig. 2a, 2b). Additional follow-up MRI performed 1 month later revealed no newly developed lesion; however, overall signal hyperintensity in the affected area was more conspicuous and confluent on fluid-attenuated inversion recovery (FLAIR) T2-weighted imaging and diffusion-weighted imaging (data not shown), suggesting lesion progression (Figure 2c, 2d).

Diagnosis, outcome and follow-up

The final diagnosis was ODS secondary to hyperosmolar hyperglycemia. Uncontrolled diabetes mellitus was managed primarily by hydration and insulin infusion, with close blood glucose monitoring. Other conservative therapies and physical rehabilitation were also implemented. Under comprehensive therapy, the patient’s general condition and neurological symptoms improved. He slowly regained mobility over the course of several weeks. His swallowing, speech, and eye movement gradually recovered. After a two-month hospitalization, he was transferred to another hospital for personal reasons. Although his clinical performance was restored, the authors believed it was imperative to confirm the resolution of the MR brain lesion.

Discussion And Conclusions

Central pontine myelinolysis (CPM) was first described in 1959 in a patient who exhibited distinctive myelin loss in the pons, which was attributed to alcoholism or malnutrition [3]. This type of myelinolysis can affect areas outside the pons, a condition that is referred to as extrapontine myelinolysis. Basal ganglia and cerebral white matter and, less commonly, the peripheral cortex, hippocampi, and lateral geniculate bodies, were sites of extrapontine myelinosis. The phrase “osmotic demyelination syndrome” is preferred to account for both entities [4].

ODS is characterized by progressive lethargy, quadriparesis, dysarthria, ophthalmoplegia, dysphasia, ataxia, and reflex changes. Clinical symptoms of extrapontine myelinolysis are variable [5]. Although the pathogenesis of ODS is not clearly understood, ODS is caused by a sudden shrinkage of brain cells (particularly oligodendrocytes), and demyelination due to a rapid change in serum osmolality [6]. It is widely accepted that the most common cause of ODS is hyperosmotic stress resulting from rapid correction of severe hyponatremia [7]. Other conditions related to ODS include alcoholism, malnutrition, prolonged diuretic use, burns (in the context of hypernatremia), post-liver transplant, AIDS, folate deficiency, and hypoglycemia [6,8,9]. The association of ODS secondary to HHS has seldom been reported.

MRI findings in our patient revealed high signal intensity in the central pons on T2-weighted FLAIR and diffusion-weighted imaging, which was suggestive of ODS. Differential diagnosis included tumorous condition, and other demyelinating diseases including multiple sclerosis and Wernicke's encephalopathy.

The patient underwent MRI for evaluation of headache one month before admission, which confirmed unremarkable findings in the pons (data not shown). In this acutely developed pontine lesion, tumorous conditions were ruled out. Multiple sclerosis was excluded because there was no other signal abnormality at the site such as Dawson's finger (T2 high signal intensity propagating centrifugally along the medullary venules and arranged perpendicular to the lateral ventricles), which is a typical finding in multiple sclerosis [10].

Common imaging findings of symmetrical Wernicke's encephalopathy include hyperintensity on T2-weighted and FLAIR imaging in the thalamus, periventricular region of the third ventricle, mammillary bodies, periaqueductal area, and tectal region [11]. These features differed from our patient’s brain lesion. Although he had a history of liver cirrhosis, he had no history of recent alcohol consumption or malnutrition.

Imaging findings of ODS typically lag behind clinical symptoms, and imaging performed after symptoms have been present for 2 weeks helps to confirm the diagnosis [12]. Computed tomography is less sensitive than MRI for ODS. Hypo-attenuated areas are observed, and are usually located within the basilar part of the pons and have no mass effect [13].

Symmetrical high signal intensity with peripheral sparing is a characteristic finding on T2-weighted and FLAIR MRI. It is also called the “trident-shape” sign, resulting from sparing of the ventrolateral pons and the pontine portion of the corticospinal tracts [13]. Low signal intensity throughout the affected areas on

T1-weighted imaging and non-enhancement after the administration of contrast material are the classic findings, and do not have a mass effect.

A newly developed lesion in the posterior tegmentum portion on follow-up MRI involved the medial longitudinal fasciculus, which correlated with our patient's symptom of lateral gaze limitation. A bilateral brachium pontis lesion usually reflects the involvement of the pontocerebellar fiber; however, gait ataxia could not be confirmed because of the patient's inability to stand due to motor weakness.

The present case is special in several respects. First, ODS occurred only in conditions of hyperosmolality. In the absence of any proven hyponatremia, chronic hyperglycemia was the likely cause for CPM in this patient. However, liver cirrhosis may accelerate ODS because of limitations in the capacity of the liver for glucose disposal, and impairment of water shifting balance [14].

Second, a clinical/radiological discrepancy was noted. Imaging findings of ODS reveal gradual progression on follow-up studies, despite the prompt correction of blood sugar levels and improvement of neurological symptoms.

There is no specific treatment of proven benefit for ODS. In some small case reports of therapeutic trials of steroids, plasmapheresis and intravenous immunoglobulin were possible choices [15, 16]. The prognosis for ODS varies from complete recovery, to death or permanent disability, and has no apparent connection to clinical features or imaging findings [13, 18]. Early recognition and the best possible supportive care may lead to favorable outcomes.

We report a rare case of hyperglycemia-related ODS that exhibited gradual progression in imaging features despite the prompt correction of blood sugar levels and improvement of neurological symptoms.

Declarations

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Consent for publication

Written informed consent was obtained from the patient for publication of this Case report and any accompanying images.

Availability of data and material

The dataset used during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

NHP: manuscript conception, supervision and manuscript final approval.

JHK: manuscript drafting and revising.

All authors have read and approved the final manuscript.

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Figures

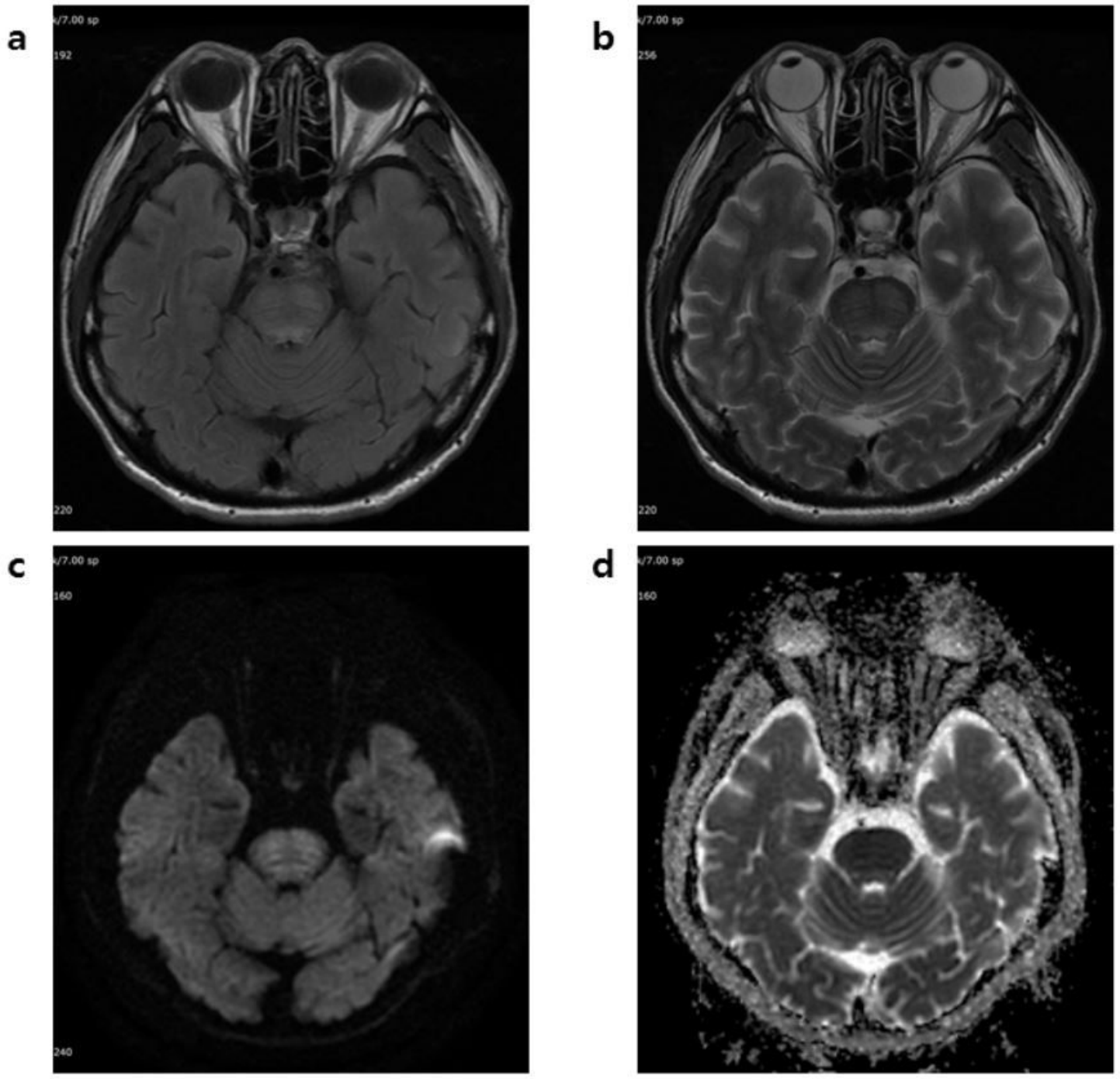

Figure 1

(a,b) Axial fluid-attenuated inversion recovery magnetic resonance (MR) image (a) and T2-weighted image (b) at the level of the pons revealing bilateral symmetrical high signal intensity in the central pons with sparing of the outer rim. (c,d) Diffusion-weighted MR image (c) and apparent diffusion coefficient (ADC) map (d) at the level of the pons revealing signal abnormality in the affected region. On the ADC map, there is no signal dropout in the region of hyperintensity, a finding consistent with T2 shine-through.

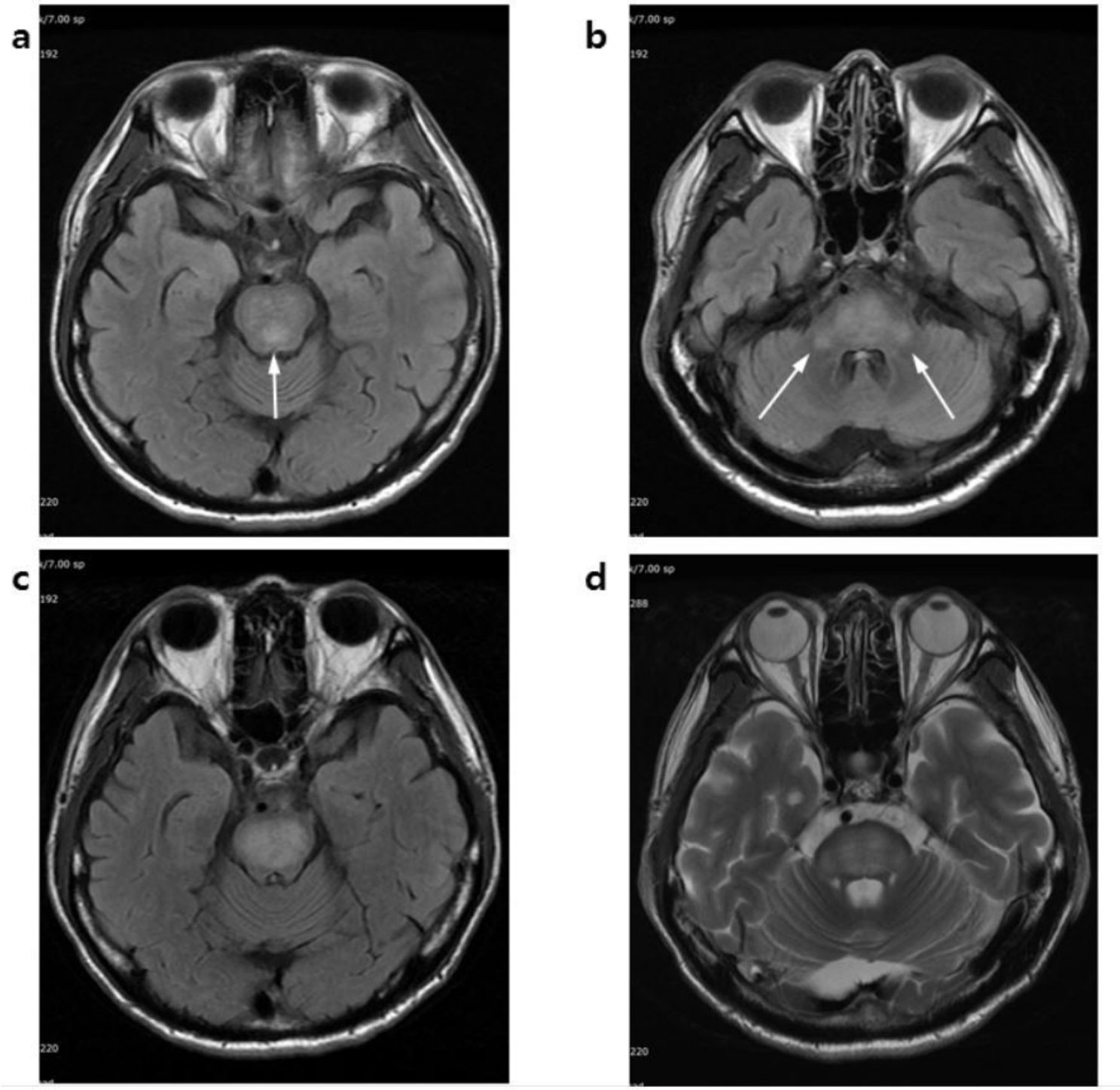

Figure 2

(a,b) Follow-up magnetic resonance (MR) imaging 10 days later. Axial fluid-attenuated inversion recovery (FLAIR) MR images at the level of the upper pons (a) and lower pons (b) reveal newly developed high signal intensity in the posterior tegmentum area (arrow in a) and bilateral brachium pontis (arrows in b). (c,d) Follow-up MR imaging 1 month later. Axial FLAIR MR images at the level of the upper pons (c) and lower pons (d) demonstrate no newly developed lesion; however, the previously established signal abnormality became more conspicuous and confluent.

Supplementary Files

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