

Case Report



A Case of Central Pontine Myelinolysis Unrelated Serum Sodium Level in Traumatic Brain Injury Patient

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Conflict of Interest

The author has no financial conflicts of interest.

ABSTRACT

Central pontine myelinolysis (CPM) is a disorder wherein variable symptoms are associated with pontine dysfunction. It has been known to occur inconstantly, particularly when serum sodium in patients with prolonged hyponatremia is rapidly corrected. Further, it is known that patients with liver diseases, malnutrition, malignancy, adrenal insufficiency, and metabolic derangements are more vulnerable to this disorder. However, there is limited literature about the occurrence of CPM in patients with traumatic brain injury, especially in those with normal serum sodium levels. A 36-year-old man having no medical history was brought to our hospital due to an open skull fracture and underwent surgery. During the hospitalization period, he showed a sudden pseudobulbar palsy and rigidity. Imaging study of the brain was characteristic for CPM. He had no fluctuation of serum sodium levels during the hospitalization period. We speculate that the brain trauma itself might cause a CPM, and its pathophysiology may not be related to rapid serum sodium correction.

Keywords: Central pontine myelinolysis; Hyponatremia

INTRODUCTION

Central pontine myelinolysis (CPM) is a unique clinical entity that reflects the pontine white matter tract. Its clinical manifestations can vary widely, and the prognosis is unpredictable. In the most severe case, patient may develop locked-in syndrome, in which only vertical eye movements and blinking are preserved. CPM was previously regarded as an irreversible state; however, contemporary series have shown that good recovery is not rare.^{2,3,5,7,9,11,16-19,22} Nevertheless, the mechanism and pathophysiology of this disorder remain unknown, and a common trigger of myelinolysis in clinical practice is the rapid correction of prolonged hyponatremia,^{23,25} which has been induced in animal models.¹⁵

In the present study, we introduce a case of CPM in a patient with traumatic brain injury and normal serum sodium levels.

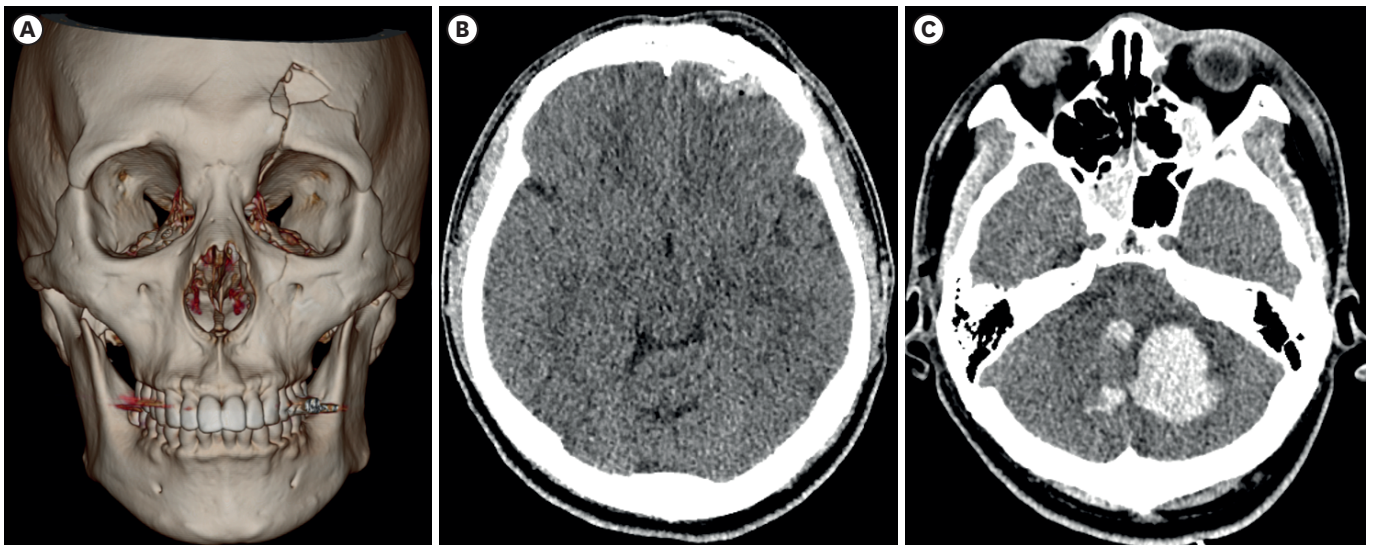


FIGURE 1. (A) Preoperative three-dimension brain CT shows compound, comminuted and depressed frontal bone fracture. (B) Preoperative brain CT shows focal hemorrhagic brain contusion on left frontal lobe. (C) Postoperative brain CT reveals acute cerebellar hemorrhage with intraventricular hemorrhage (4th). CT: computed tomography.

CASE REPORT

A 36-year-old man presented to our hospital with a head injury due to a fall from a great height. He had forehead laceration and exhibited no neurological deficits. Initial brain computed tomography (CT) showed a compound, comminuted, and depressed fracture in the left frontal bone associated with small focal cerebral contusions (**FIGURE 1A & B**). His Glasgow Coma Scale (GCS) score was 15.

We planned an emergency operation for his skull fracture. After performing craniectomy, we carefully checked the operative field. The dura was intact, and there was no evidence of cerebrospinal fluid leakage. Irrigation of the operative field and cranioplasty using bone cement were performed. No complications occurred during surgery. After the surgery, the anesthesiologist reported no respiratory recovery. We performed brain CT again immediately, and acute cerebellar hemorrhage with acute obstructive hydrocephalus was observed. His GCS score at this point was 5 (**FIGURE 1C**). We then performed extraventricular drainage followed by catheter insertion into the cerebellar hematoma. Follow-up serial brain CT showed an improvement in cerebellar hemorrhage and hydrocephalus. His consciousness level gradually improved to a GCS score of 14.

After the surgery, the patient showed gradual quadriparesis and rigid spasticity, and suddenly developed pseudobulbar palsy 52 days after the operation. Therefore, we performed brain magnetic resonance imaging (MRI), which showed a high signal intensity in the central pons on T2 fluid-attenuated inversion recovery (FLAIR) sequence, and sparing of peripheral pons compatible with CPM (**FIGURE 2**) on diffusion-weighted imaging. We checked his serum sodium level retrogradely, but no hyponatremia was observed during the admission period (**FIGURE 3**).

The patient died due to aspiration pneumonia approximately 2 weeks later.

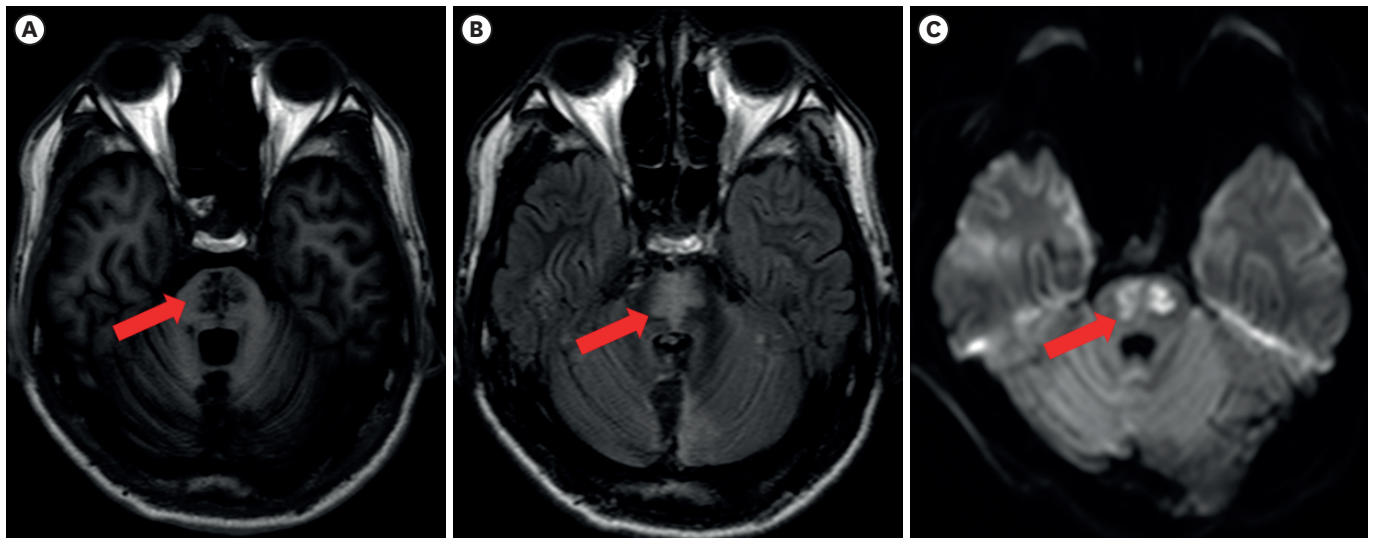
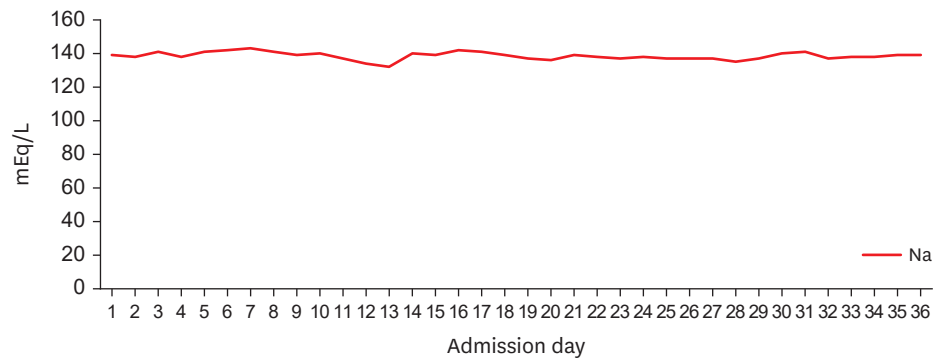


FIGURE 2. Brain magnetic resonance imaging shows high signal intensity on central pons (arrows) sparing peripheral pons compatible with central pontine myelinolysis. (A) T1 weighted image, (B) fluid-attenuated inversion recovery, (C) diffusion weighted image.



1	2018-04-26	139	13	2018-05-06	132	25	2018-05-18	137
2	2018-04-26	138	14	2018-05-07	140	26	2018-05-19	137
3	2018-04-27	141	15	2018-05-08	139	27	2018-05-20	137
4	2018-04-28	138	16	2018-05-09	142	28	2018-05-21	135
5	2018-04-29	141	17	2018-05-10	141	29	2018-05-24	137
6	2018-04-30	142	18	2018-05-11	139	30	2018-05-28	140
7	2018-04-30	143	19	2018-05-12	137	31	2018-05-31	141
8	2018-05-01	141	20	2018-05-13	136	32	2018-06-04	137
9	2018-05-02	139	21	2018-05-14	139	33	2018-06-07	138
10	2018-05-03	140	22	2018-05-15	138	34	2018-06-11	138
11	2018-05-04	137	23	2018-05-16	137	35	2018-06-18	139
12	2018-05-05	134	24	2018-05-17	138	36	2018-06-25	139

FIGURE 3. Serum sodium level during hospitalization period. There were no hyponatremic event and serum sodium concentration was within normal limits all the time (minimal 132 mEq/L to maximal 140 mEq/L).

DISCUSSION

CPM is an uncommon demyelinating disorder first introduced by Adams et al.¹⁾ in 1959. Patients with alcoholism or malnutrition have been observed to develop spastic quadriplegia,

pseudobulbar palsy, and varying degrees of encephalopathy or coma from acute, non-inflammatory demyelination centered within the basis pontis.²⁰⁾ Histologically, neurons and axons are preserved, differentiating this process from a central pontine infarct.¹²⁾

The pathophysiology of this disorder remains unclear. Until now, the most reliable theory is the osmotic demyelination-related serum sodium level. In a prolonged hyponatremic state, rapid serum sodium correction leads to intracellular fluid extraction.^{4,14)} This results in cellular dehydration and possibly enhanced apoptosis, which causes the death of vulnerable oligodendroglial cells. The distribution of the lesions parallels the distribution of oligodendroglial cells in the central pons, thalamus, putamen, and other extrapontines.¹⁴⁾ Diagnosis is based on the detection of electrolyte abnormalities and MRI findings. Typical radiological findings on brain MRI include hyperintense lesions in the central pons or associated extrapontine structures on T2-weighted imaging and FLAIR sequences with corresponding hypointensity on T1-weighted sequences.²¹⁾

Many studies conducted recently have revealed that these myelinolytic disorders, all under the umbrella term “extrapontine myelinolysis,” occur in the basal ganglia, white matter of the cerebellum, thalamus, or hippocampus.

There are several differential diagnostic points. Apart from CPM, the representative types of hyperintense brain stem lesion in T2 weighted images are diffuse glioma, lymphoma, brain stem injury, Wallerian degeneration, and Behcet’s disease.¹³⁾ In the present case, we had to distinguish CPM from brainstem injury. The most common cause of brain stem trauma is indirect shear-strain forces that cause diffuse axonal injury. In such cases, areas of petechial hemorrhage can be identified outside the region where the brain stem abuts the cerebral surface.⁸⁾ We performed MRI, particularly susceptibility-weighted imaging, but no petechial hemorrhage was observed on the pons or other brainstem lesions. The patient had no medical problems, and brain stem tumors or other neurodegenerative diseases were excluded.

CPM is known to be more vulnerable to heavy alcoholism, liver disease, malignancy, pregnancy, adrenal insufficiency, malnutrition, and metabolic derangements, such as hypoglycemia, hypokalemia, and hypophosphatemia. However, few studies have correlated traumatic brain injury with CPM to date.

We injected the patient with 100 mL 20% mannitol daily from the admission day to the tenth day of admission. The major effect of mannitol is an increase in fractional excretion of sodium and urea, which causes hypo- or hypernatremia. In addition, this traumatic brain injury caused the syndrome of inappropriate antidiuretic hormone secretion (SIADH). Considering all of these, CPM can occur in patients with traumatic brain injury. However, defining these two cases in our patient was difficult because his sodium level was within the normal limits. It is unclear why he developed CPM, but we think that the osmotic demyelination theory cannot fully satisfy our case.

Yoshihisa et al.²⁴⁾ have reported that disrupting the blood-brain barrier (BBB) plays a major role in CPM. The BBB is a semi-permeable barrier that separates circulating blood from the brain environment to regulate molecules that undergo influx and efflux; subsequently, BBB disruption leads to two processes. The first involves an increase in paracellular transport, indicated by a loss of tight junction proteins, allowing the passage of molecules that would usually be restricted. This includes an influx of immune cells, such as neutrophils, that can

exacerbate the inflammatory response. The second process occurs due to an increase in transcytosis across the endothelial cell, leading to the transport of larger molecules and serum proteins, such as albumin, which are normally restricted from entering the brain. Through this complicated process, CPM may occur after brain trauma. We believe that a traumatic brain injury can also induce BBB disruption, which in itself may cause CPM, as in our case.

There is a limit in this report. It is the patient had a delayed cerebellar hemorrhage and hydrocephalus. These events might affect intracranial pressure, especially posterior cranial fossa, and make this brain stem lesion mimicking CPM. Due to the nature of brain stem, it is impossible to take a biopsy, so this pontine lesion called CPM may be a result of secondary change due to increased intracranial pressure.

CONCLUSION

Overall, As previously stated, CPM might occur in patients with traumatic brain injury at any time, unrelated to serum sodium levels. We believe that brain trauma itself can cause BBB disruption and subsequent CPM with or without disruptions in the serum sodium level. In this regard, rapid sodium correction may not be the sole pathophysiological mechanism. Further studies on the correlation between trauma and CPM are required.

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