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【 CASE REPORT 】

Hyponatremia with Loss of High Signal Intensity in the Posterior Pituitary Lobe on T1-weighted Magnetic Resonance Imaging

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Abstract:
Herein, we report on an 82-year-old woman who presented with anorexia. The patient had hyponatremia with preserved urinary osmotic pressure. T1-weighted magnetic resonance imaging (MRI) showed a lack of high signal intensity (SI) in the posterior pituitary lobe. Based on the patient's high levels of N-terminal prohormone of brain natriuretic peptide (NT-proBNP), heart failure was suspected. The heart failure may have caused arginine vasopressin (AVP) secretion. The depletion of AVP secretory granules may therefore cause the posterior pituitary gland to disappear on T1-weighted MRI.

Key words: hyponatremia, lack of high signal intensity in the posterior pituitary lobe, depletion of the posterior pituitary

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Introduction

On T1-weighted magnetic resonance imaging (MRI), high signal intensity (SI) in the posterior pituitary is thought to indicate neurosecretory granules containing antidiuretic hormone (ADH) secretions (1). We herein report a patient with anorexia and hyponatremia whose T1-weighted MRI findings showed a lack of high SI in the posterior pituitary lobe.

Case Report

We encountered an 82-year-old woman who had been hypertensive since she was 40 years old. The patient attended a nearby clinic for the treatment of hypertension and hyperlipidemia. She was prescribed the following medications: a 20-mg nifedipine extended-release tablet after breakfast, a 10-mg pravastatin tablet after breakfast, two 150-mg ranitidine tablets after breakfast and dinner, and three 25-mg dipyridamole tablets after each meal.

The patient's family history included the following: her mother had gastric cancer, her sister had a gastric ulcer, and her brother had cerebral hemorrhaging. She had been experiencing frequent urination since June 2014 and had had headaches since the beginning of November 2015. In the beginning of December 2015, the patient was admitted to the Department of Internal Medicine at our hospital for observation, presenting with anorexia. Her serum sodium level was 124 mEq/L. On admission, the following parameters were recorded: height, 135.5 cm; weight, 44.7 kg; blood pressure, 144/74 mmHg; pulse rate, 60 beats/min; and body temperature, 36.6℃. The patient had been experiencing symptoms of dryness of the oral cavity and throat for several years.

A physical examination did not reveal any abnormal findings in the patient's chest and abdomen, and no edema was detected in her lower extremities. On hospital admission, a laboratory examination revealed a urinary sodium level of > 20 mEq/L despite low serum sodium levels. In addition, despite low serum osmolality, the urine osmolality was maintained. The patient's serum sodium was 124 mEq/L, and arginine vasopressin (AVP) was 1.3 pg/mL (Table 1, 2). A chest radiograph revealed a cardiothoracic ratio of 56%;

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Table 1. Laboratory Data Obtained on Admission. Hyponatremia and Elevated NT-proBNP Levels were Observed.

Hematology and biochemistry			
WBC	4,310 /μL	TP	7.9 g/dL
RBC	458 $\times 10^4$/μL	Alb	4.7 g/dL
Hb	12.3 g/dL	T-Bil	1.2 mg/dL
PLT	28.0 $\times 10^4$/μL	GOT	29 IU/L
Na	124 mEq/L	GPT	23 IU/L
K	4.6 mEq/L	LDH	184 IU/L
Cl	87 mEq/L	ALP	144 IU/L
BUN	18.6 mg/dL	LDL-CHO	77 mg/dL
Cr	0.80 mg/dL	GLU	111 mg/dL
UA	3.2 mg/dL	NT-pro BNP	1,261 pg/mL

Arterial Blood Gas : pH 7.457, pCO_2 31.9 mmHg, pO_2 110.0 mmHg, SaO_2 98.4% (room air)

Urinalysis : Glucose (-), Protein (-), Occult blood (-), Urinary sodium 94 mEq/L, Urinary potassium 85.3 mEq/L, Urinary chloride 78 mEq/L

Table 2. Findings from an Endocrinological Examination. Despite the Low Serum Osmolality, the Urine Osmolality was Maintained.

			Normal Range
FT3	2.15	pg/mL	(2.30–4.30)
FT4	1.45	ng/dL	(0.90–1.70)
TSH	1.080	μIU/mL	(0.500–5.00)
ADH	1.3	pg/mL	(0.3–3.5)
ACTH	18.2	pg/mL	(7.2–63.3)
Cortisol	24.0	μg/dL	(4.0–18.3)
Renin Activity	0.8	ng/mL/hr	(0.3–5.4)
Aldosterone	109	pg/mL	(35.7–240)
Serum Osmolarity	254	mOsm/kg H_2O	(276–292)
Urine Osmolarity	526	mOsm/kg H_2O	

mild pulmonary congestion was suspected. Supraventricular premature contractions and left ventricular hypertrophy were observed on electrocardiogram. In addition, echocardiography was performed at the end of January 2017 after discharge. The left ventricular ejection fraction was 82.4%, and no pericardial effusion was noted; however, aortic valve insufficiency (Sellers III) was observed.

In the middle of December 2015, on admission day 5, MRI of the brain was performed. T1-weighted MRI of the pituitary showed a lack of high SI in the posterior pituitary gland (Fig. 1). An anterior pituitary test using corticotropin-releasing hormone, thyrotropin-releasing hormone, and luteinizing hormone-releasing hormone showed increases in adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone, luteinizing hormone, and follicle-stimulating hormone activity. In addition, elevated cortisol levels with an increase in ACTH activity were observed (Table 3). The anterior pituitary function appeared to be sufficiently maintained.

During the patient's hospital stay, an intravenous drip containing 500 mL of Ringer's solution with added glucose was administered for 15 days. Forty-three days after admission, in mid-January 2016, the patient was treated with fludrocortisone (0.05 mg in total) for 11 days, divided into periods of 4 and 7 days. Her serum sodium levels improved from 122 to 126 mEq/L. During her hospital stay, the patient progressed to receiving oral administration, and her malaise decreased. She was discharged on day 76 after admission, at the end of February 2016. Her serum sodium levels increased to 137 mEq/L after discharge (Fig. 2). In February 2016 during hospitalization, the patient had sensory hypersensitivity, including nighttime insomnia, abnormal sweating, abnormal sensations of heat and cold, and increased sensitivity to smells; however, this hypersensitivity improved after the patient was discharged.

Discussion

We encountered a patient with hyponatremia who lacked high SI in the posterior pituitary gland on T1-weighted MRI. The relationship between the neurosecretory granules of the posterior pituitary gland and the high SI at the same site on T1-weighted MRI has been investigated using rabbits, which release plasma ADH when a hypertonic saline load is administered (1). When the amount of neurosecretory granules (including ADH) in the posterior pituitary gland decreased due to hypertonic saline loading, the high SI in the same part of the T1-weighted MRI also decreased. Therefore, the high SI in the posterior pituitary observed on T1-weighted MRI is believed to indicate the presence of neurosecretory granules containing ADH at the same site. In experiments in which ADH secretion was induced by hypertonic saline loading in dogs, a significant negative correlation was observed between the plasma ADH concentration and the high SI in the posterior pituitary gland (2). Therefore, the high SI in the posterior pituitary gland observed on T1-weighted images of normal dogs may be a result of ADH stored at the same site.

Central diabetes insipidus is associated with high SI loss in the posterior pituitary gland on T1-weighted MRI (3). In central diabetes insipidus, the osmotic pressure of urine decreases, and the plasma osmotic pressure increases because of polyuria. However, in our case, the osmotic pressure of urine was maintained even though the plasma osmotic pressure had decreased. Therefore, this patient was not diagnosed with central diabetes insipidus.

Furthermore, patients with diabetes and poor blood glucose control also demonstrate high SI loss in the posterior pituitary gland (4). In patients with diabetes and poor glycemic control, ADH stores in the posterior pituitary gland are decreased. In our case, the patient had no history of diabetes; furthermore, her blood glucose level at the time of admission was 111 mg/dL. Therefore, she was also not diagnosed with diabetes with poor glycemic control.

ADH is also secreted under conditions such as hemor-

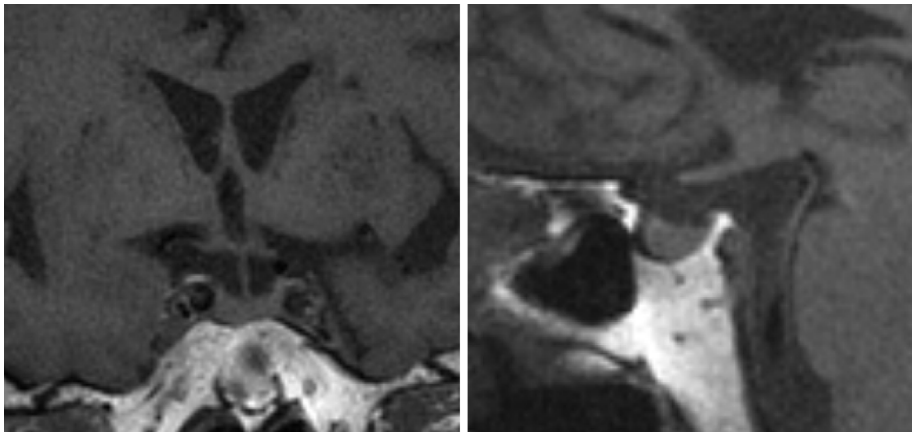

Figure 1. **MRI findings of the brain. In mid-December 2015, on admission day 5, MRI of the brain was performed. T1-weighted MRI of the pituitary showed a lack of high SI in the posterior pituitary gland.**

Table 3. **Tripartite Load Test of the Anterior Pituitary Using Corticotropin-releasing Hormone, Thyrotropin-releasing Hormone, and Luteinizing Hormone-releasing Hormone. The Anterior Pituitary Function was Maintained.**

		Previous value	30-min value	60-min value	90-min value
TSH	(μIU/mL)	1.18	13.17	11.05	8.7
PRL	(ng/mL)	6.16	72.92	41.60	26.61
LH	(mIU/mL)	19.24	49.73	64.68	59.49
FSH	(mIU/mL)	59.49	64.97	75.35	78.77
ACTH	(pg/mL)	9.3	34.6	38.0	30.3
Cortisol	(μg/dL)	19.6	28.6	26.8	26.9

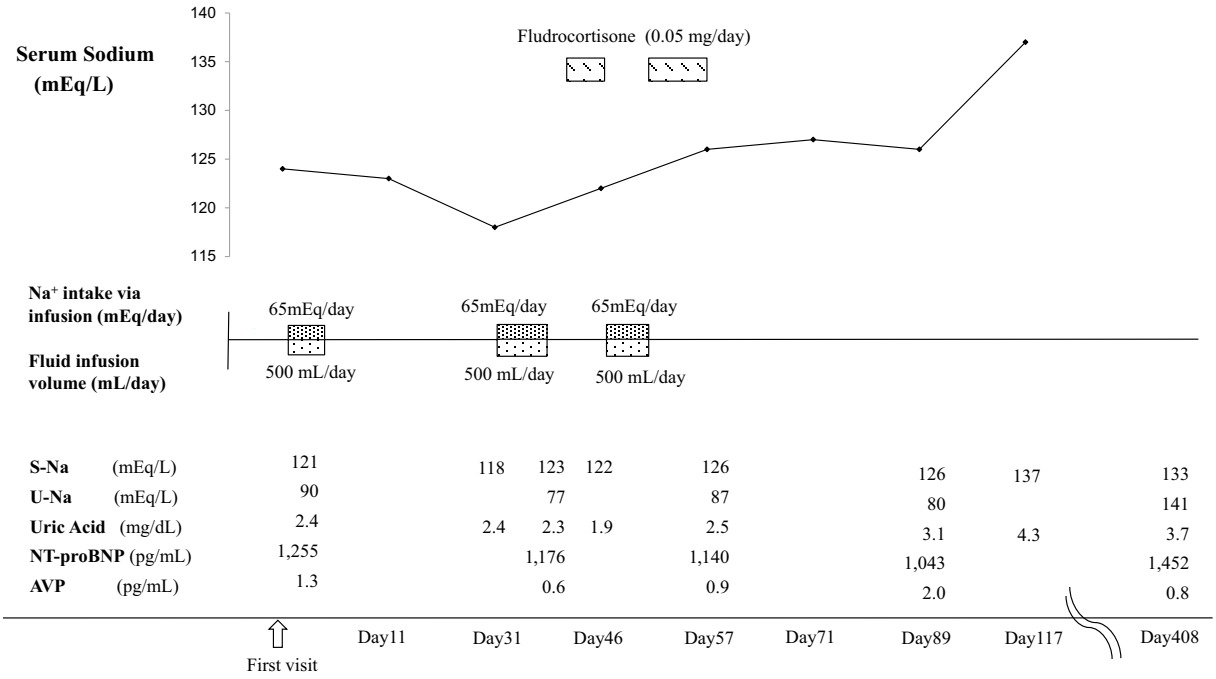

Figure 2. **Clinical course. From day 43, the patient was treated with fludrocortisone at 0.05 mg for 11 days, divided into periods of 4 and 7 days. This treatment resulted in an increase in the serum sodium level from 122 to 126 mEq/L.**

rhagic shock (5) and septic shock (6). Under such circumstances, the ADH stores in the posterior pituitary gland are depleted. However, the patient's blood pressure at the time of admission was 144/74 mmHg, and she was not in shock.

In syndrome of inappropriate ADH secretion (SIADH), the high SI observed on T1-weighted MRI in the posterior pituitary gland disappears (7, 8), and ADH is secreted from the posterior pituitary even at low osmotic pressure. Therefore, ADH stores in the posterior pituitary are depleted, resulting in the possible disappearance of the high SI. In our case, the osmotic pressure of urine was maintained despite the decreased plasma osmotic pressure; the patient's uric acid levels also improved in conjunction with an improvement in blood sodium levels. These clinical features are characteristic of SIADH. However, our patient had high levels of N-terminal prohormone of brain natriuretic peptide (NT-proBNP). Therefore, in our case, heart failure may have promoted the excess secretion of vasopressin and possibly induced depletion of the posterior lobe.

The secretion of ADH is constantly suppressed via baroreceptors present in the carotid sinus, aortic arch, atrium, and ventricle. Under conditions of heart failure, the cardiac output decreases along with the effective circulating blood volume, so the sensitivity of the baroreceptor decreases as well. If the suppression of ADH secretion decreases, ADH secretion is enhanced, and ADH storage in the posterior pituitary may be depleted (9).

After discharge, the patient underwent echocardiography at the hospital's outpatient clinic. Her left ventricular ejection fraction was maintained at 82.4%, and no pericardial effusion was observed. However, aortic valve insufficiency (Sellers III) was observed. Even when the left ventricular ejection fraction is maintained, heart failure may occur (10). Hyponatremia may occur in 12.9-25.4% of patients with heart failure whose left ventricular ejection fraction is maintained (11). In addition, our patient also experienced hypersensitivity. Therefore, mental stress may have caused her AVP secretion (12).

Our patient's serum sodium level slightly increased from 122 before to 126 mEq/L after the administration of fludrocortisone (0.05 mg in total) for 11 days. Fludrocortisone is a mineralocorticoid that promotes sodium reabsorption in the distal renal tubule. These effects may occur in cases of mineralocorticoid-responsive hyponatremia of the elderly (MRHE) (13), SIADH, and heart failure. Therefore, fludrocortisone administration may not be a diagnostic treatment for MRHE.

In our case, the patient's hyponatremia improved after discharge. The effects of fludrocortisone may have emerged over time, or fludrocortisone may have triggered the metabolic improvement. However, in order to make any definitive conclusions it will be necessary to study other similar cases.

Conclusions

The loss of high SI in the posterior pituitary gland on T1-weighted MRI indicates the depletion of vasopressin storage. The factors that should be considered in cases of hyponatremia and the loss of high SI in the posterior pituitary gland on T1-weighted MRI are unclear. In elderly patients with hypotonic hyponatremia, the pathology is complex; it is therefore difficult to distinguish between SIADH, MRHE, and heart failure. Our experience may provide important insight into the evaluation of other cases of hyponatremia with depletion of the posterior pituitary gland on T1-weighted MRI and ADH secretion.

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The authors state that they have no Conflict of Interest (COI).

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