Case Report

Cerebral salt wasting syndrome following a traumatic frontal lobe hematoma : A case report

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Abstract

Background: Cerebral Salt Wasting Syndrome (CSWS) is a rare complication of intracranial pathology characterized by hyponatremia and extracellular volume depletion. It is often confused with other sodium and water balance disorders, such as Syndrome of Inappropriate Antidiuretic Hormone Secretion (SIADH) and Central Diabetes Insipidus (CDI), making early diagnosis and appropriate management crucial.

Case Presentation: We present the case of a 68-year-old male with type 2 diabetes mellitus who suffered a traumatic frontal lobe hemorrhagic contusion following a fall. The patient developed polyuria and hyponatremia on the 6th day of admission, initially misdiagnosed as CDI and treated with desmopressin. However, despite treatment, his urine output continued to rise, and hyponatremia persisted. Subsequent evaluations, including urine and serum osmolarity, high urinary sodium levels, and imaging studies, led to the diagnosis of CSWS. Treatment was adjusted to include intravenous isotonic saline and fludrocortisone, significantly reducing urine output and correcting serum sodium levels. The patient was successfully discharged on the 25th day with stable electrolyte levels.

Conclusion: This case highlights the diagnostic challenges in differentiating CSWS from other sodium balance disorders, particularly CDI, in patients with traumatic brain injury. It emphasizes the importance of careful monitoring of urine and serum biochemistry, fluid status, and clinical progression to ensure accurate diagnosis and effective management. Early recognition and appropriate therapy for CSWS, including sodium and fluid replacement, can prevent further complications and improve patient outcomes.

Introduction

Central disorders of water and sodium balance are known complications after brain injury. Insult surrounding the hypothalamus and pituitary gland increases the risk for antidiuretic hormone (ADH) dysregulation, causing transient or permanent central diabetes insipidus (CDI) and, in some cases, syndrome of inappropriate antidiuretic hormone (SIADH). Brain injury has also been associated with a cerebral salt wasting syndrome (CSW) that can occur with CDI, which is treated with fluid and sodium replacement.[1]

Polyuria is a condition characterised by the excretion of an excessively large volume of urine over a 24 h period and is defined as a urine output in excess of 40 ml/kg body weight.[2] From a pathophysiological point of view, it is classified into two types: polyuria due to a greater excretion of solutes (urine osmolality >300 mOsm/L) or due to an inability to increase solute concentration (urine osmolality <150 mOsm/L). Sometimes both mechanisms can coexist (urine osmolality 150–300 mOsm/L).[3] CDI is usually associated with hypernatremia and polyuria, while the CSW presents with hyponatremia and polyuria. On the other hand, SIADH presents with hyponatremia without intravascular volume depletion.[4]

Cerebral Salt Wasting Syndrome (CSWS) is extracellular volume depletion caused by impaired renal sodium transport in patients with intracranial disease or trauma with normal kidney and thyroid function. In addition to symptomatic acute hyponatremia and dehydration, CSWS is also associated with symptomatic acute hyponatremia. This syndrome is still poorly understood, but it is known that defects in renal sodium transport led to decreased extracellular volume and cascade changes. The abnormalities in the proximal tubule cause excessive sodium loss.[5]

We reported and discussed the diagnostic approach and management of a 68-year-old man with dengue infection who experienced polyuria and hyponatremia following frontal lobe contusion after a fall and was treated at Bir Hospital, Kathmandu.

Case Description:

A 68 years old male with type 2 DM was admitted to hospital with a history of acute onset of severe headache, right-sided ear bleeding, vomiting, and confusion with a history of a fall from a standing height. On examination, he was confused, opening his eyes on verbal command and obeying motor commands with GCS of 13/15. His vitals were BP of 110/60 mmHg with MAP of 76mmHg, pulse rate of 80 respiratory rate of 18 and temperature of 98.9. There was no facial drooping, weakness or abnormal sensation of any body parts, no urinary or fecal incontinence. A cerebral CT was performed which revealed hemorrhagic contusion in left frontal lobe (4.03*2 cm) with perilesional edema and midline shift. There was linear undisplaced fracture of right occipital bone extending to right mastoid with a small extradural hematoma; the swelling was noted in the right occipital region.

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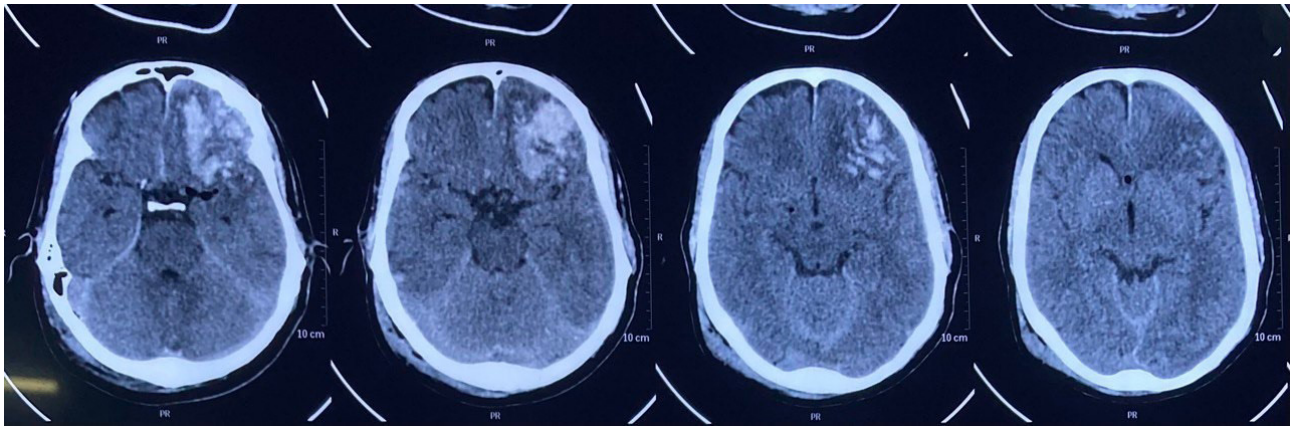


CBC showed platelet counts of 60000 and dengue IgG was positive. Cerebral Magnetic Resonance Angiography and Venography was performed which revealed intraparenchymal hematoma measuring 5.2*4.2 cm noted in the left frontal lobe with no abnormality of cerebral arteries or venous system.

The patient was admitted to Neuro High Dependency Unit where he received Dexamethasone, injection ceftriaxone, anti-seizure prophylaxis with injection phenytoin, insulin, and kabilyte and was kept nil per oral.His neurological status was progressively improving as he was spontaneously opening his eyes and oriented to

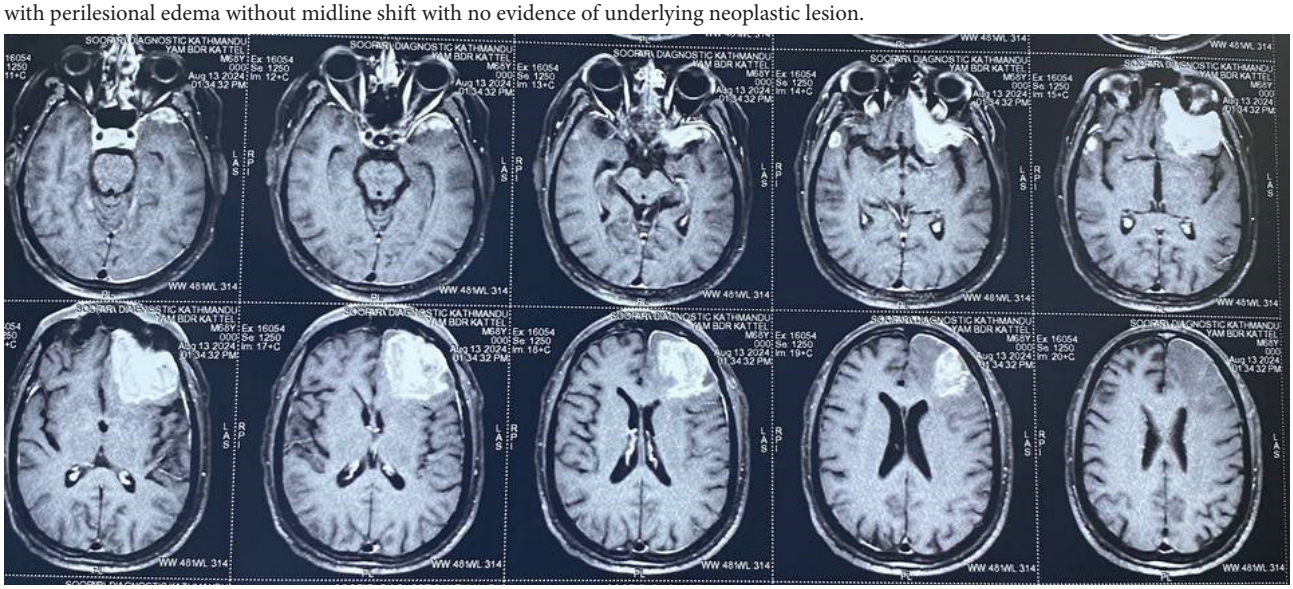
time/place and person. By 5th day, his GCS was 15/15 and his vitals were normal. On examination, a linear bruise of 2cm * 5cm size is noted posterior to right ear however there were no any bruise or abrasions in any other parts of his body. His platelet counts rose to 120000. Thus, he was transferred to Neuro ward on the same day.

On the 6th day of admission, his 24 hours urine output increased to 4000ml with total input of 1550 ml. Urine osmolarity was 462.83(normal range:150-1500), spot urine sodium was high135(normal range:30-90), serum osmolarity was elevated with value of 301.39(normal range:285-295) and Serum sodium was low with value of 132(normal range:135-145).

On the subsequent day, a diagnosis of Central Diabetes Insipidus was made and treatment with desmopressin nasal spray was begun. 2 sprays of Desmopressin 0.01% nasal spray were given in one of the nostrils. However, over the next 24 hours, his urine output did not reduce rather it was increased to 5160ml with a total input of 3740ml. He also received desmopressin the second time on the 10th day as his urine output was a record high of 6600ml while his input was only 3600.

Endocrine was then consulted and ordered to stop desmopressin. After 3 days of stopping desmopressin, serum and urine were sent for examination revealing urine osmolarity of 402.7, UNa of 120, and Serum osmolarity of 274. They diagnosed the condition as cerebral salt-wasting syndrome secondary to brain insult. They tried managing the condition with increased intravenous normal saline where they upscaled 2 pints of NS to 4 pints of NS over 24 hours.

On the 19th day of admission, a contrast MRI brain with Magnetic resonance spectroscopy was ordered to rule out the possibility of any malignant mass. It revealed a lobar hemorrhage on the left(4.7*3.9 cm- slightly reduced than previous dimensions) and a small one on the left with perilesional edema without midline shift with no evidence of underlying neoplastic lesion.



Tumor markers including CEA, CA19-9, AFP, and PSA were within the normal range. and Underlying any seizure activity of the brain was ruled out by EEG; his serum calcium and magnesium levels were also normal. Hormonal studies including thyroid function test and 8 am serum cortisol was also within normal range.

His 24hrs Urine Input and Output record is as follows:

Day	Input	Output	Na	K	Blood sugar	Ur	Cr	Uosm	UNa	Sosm
6th day	1550	4000	132	4.0	-	25	0.7	462.83	135	301.39
7th day	3740	5160								
8th day	3500	5200 (desmopressin 2 spray was given)								
9th day	3200	4400								
10th day	3600	6600 (desmopressin 2 spray was given								
11 th day	3700	3800	124	3.10		22	0.6			
12th day	3850	4160	124	3.30						
13th day	2500	5100	130	3.2		20	0.6			
14th day	2720	4200	133	3.6		17	0.6	402.7	120	274
15th day	1980	4850	137	3.7	73					
16th day	3050	4700								
17th day	3750	4200 (Tab Fludrocortisone 50 mcg daily started)	134	4.3						
18th day	3030	3750	138	4.1	98					
19th day	2740	3100	134	3.8	112					
20th day	3230	3180	138.75	4.03		20	0.8			
21th day	2480	1500	138	3.9						
22th day	2420	1750 (Tab Fludrocortisone stopped)	138	3.6						
23rd day	2250	2160	141	3.5						
24th day	2100	1980								

Hematology Parameters:

Day	Hb	TC	Platelets
1st day	13.5	9620	66000
2nd day	12.8	9060	120000(After 4 pints of PRP being transfused)
11th day	12.8	7700	151000
20th day	12.8	5300	170000

On the 17th day, fludrocortisone 50 mcg once daily was started. The subsequent urine volume continued to decrease, thus the drug was stopped on the 22nd day. His blood parameters including platelets normalized by the 11th day with a total platelets count of 151000. The patient was discharged on the 25th day from the hospital with an advice to follow up in a week with a renal function test and random blood sugar report.

Discussion:

Cerebral Salt Wasting Syndrome (CSWS) is extracellular volume depletion caused by impaired renal sodium transport in patients with intracranial disease or trauma with normal kidney and thyroid function.[5] According to Dholke et. Al, decreased renal sympathetic responses and cerebral natriuretic factors play a role in the pathogenesis of CSWS although it has been incompletely studied. Maintaining a positive sodium balance and adequate hydration can help in the treatment.[6] Zhang describes that the basis for diagnosing CSWS includes hyponatremia (<135 mmol/L), increases in urine Na concentration (> 18 mmol/L), large urine volume (>3000 mL/d), and low blood.[7] In a study, John and Day et. Al described that hyponatremia in acute brain disease is a common occurrence. Although the syndrome occurs most often in patients with stroke, intracerebral hemorrhage, subarachnoid hemorrhage, and intracranial surgery, it may develop in patients with TBI who have increased intracranial pressure. Originally, excessive natriuresis, called cerebral salt wasting, and later the syndrome of inappropriate antidiuretic hormone secretion (SIADH), were considered to be the causes of hyponatremia. In recent years, it has become clear that most of these patients are volume-depleted and have a negative sodium balance, consistent with the original description of cerebral salt wasting.[8] Betjes et. Al showed that three common electrolyte imbalances are associated with the hypothalamic-pituitary dysfunction experienced by patients with TBI: central neurogenic diabetes insipidus (CNDI), syndrome of inappropriate secretion of antidiuretic hormone (SIADH), and cerebral salt-wasting syndrome (CSWS). CNDI is associated with hypernatremia, whereas SIADH and CSWS are associated with hyponatremia. Early recognition of all 3 syndromes is important in patients with TBI to prevent further neurological deterioration.[9]

According to a study by Lara et.al, acute head trauma can lead (directly or indirectly) to dysfunction of the hypothalamic neurons secreting antidiuretic hormone (ADH) or of the posterior pituitary gland causing post-traumatic DI (PTDI). PTDI is usually diagnosed in the first days after the trauma presenting with hypotonic polyuria.[10] In a textbook, Joseph G. Verbalis states that most outpatients with diabetes insipidus are not hypernatremic because the polydipsia produced by a normal thirst response is generally sufficient to maintain water homeostasis. Instead, they present with polyuria, polydipsia, and a normal sodium level.[11] According to Christ-Crain in a study, For decades, the "gold standard" for differential diagnosis has been the standard water deprivation test. Fluid restriction may not be appropriate in patients who had an acute stroke due to the increased risk of decreased cerebral perfusion and is contraindicated when the patient is hypovolaemic, such as hyponatremia caused by CSWS.[12]

Lara et. Al in a study states that The increased polyuria secondary to the rise in natriuresis associated with CSWS might be erroneously interpreted as a sign of poor control of the DI, thereby leading to therapeutic mistakes.[10]

Lin et. Al in a study described that the Treatment of Diabetes Insipidus is based on adequate water restoration, and the administration of desmopressin whereas the treatment of CSW cannot simply be based on Na and water: high dose fludrocortisone (0.2 - 0.4 mg/day) is often indicated.[13]

According to the study by John K. Maesaka et al., the primary treatment for CSWS is replacing water and sodium lost due to diuresis and natriuresis. For mild hyponatremia, 0.9% sodium chloride should be sufficient, and 3%sodium chloride should be administered for severe hyponatremia.[14] A study by Dholke et. Al revealed that some clinicians have found the use of mineralocorticoids in CSWS useful. Fludrocortisone is one such drug, which promotes the increased reabsorption of sodium and the loss of potassium by the renal distal tubules.[6]

In a case series reported by Taplin et. Al showed the report of 4 patients with cerebral salt wasting, all of whom presented with hyponatremia in the presence of known intracerebral pathology. All had clinically significant hyponatremia, and 3 had hyponatremic seizures. Two of the patients also satisfied clinical criteria for diabetes insipidus. They all were treated with regimens using increased sodium and fluid administration but experienced ongoing salt wasting. Fludrocortisone was instituted in all 4 patients and 3 resulted in rapid improvement in net sodium balance, enabling the weaning of hypertonic fluids and stabilization of serum electrolytes. The duration of therapy was 4 to 125 days.[15]

Similarly in a case report by Lee et. Al reported a 72-year-old gentleman with CSWS following head trauma whose hyponatremia was corrected with 3% hypertonic saline. Withdrawal of hypertonic saline 3 days later led to a decrease in serum sodium level to 120 mEq/L. Attempt to withdraw hypertonic saline 3 days later again led to a fall in serum sodium level with persistent inappropriate natriuresis. N-terminal pro-brain natriuretic peptide level was not elevated. Plasma renin activity and aldosterone concentration measured on day 6 were undetectable. Treatment with fludrocortisone was commenced initially at 0.2 mg/d and later reduced to 0.1 mg/d, and a rapid reduction in natriuresis and restoration of serum sodium level to the normal range was observed.[16]

We treated this patient with isotonic 0.9% Normal saline with oral sodium bicarbonate supplementation daily. Although it corrected serum sodium a little; it did not reduce the urinary output. Thus Fludrocortisone 50 mcg was used daily which gradually improved serum sodium while decreasing 24 hours of urine output.

Conclusion:

We reported a case of Cerebral Salt Wasting Syndrome in a patient with traumatic frontal lobe hematoma who presented with hyponatremia and polyuria. The correct diagnosis of the etiology of polyuria following brain insult is important as it might confuse central diabetes insipidus and cerebral salt wasting syndrome. The treatment approach in these cases is almost the opposite. While water deprivation and desmopressin are treatment modalities for Central Diabetes insipidus; sodium and water supplementation along with mineralocorticoids are of help for Cerebral Salt wasting Syndrome. Although the actual mechanism of CSW remains uncertain, and it may not be universal in all cases of CSW, the current case indicates that fludrocortisone therapy may be of benefit in selected adult patients with CSW and refractory hyponatremia.

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