Case Report

A Case of Severe Exercise Associated Hyponatremia after Running Marathon

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Abstract

Exercise associated hyponatremia (EAH) can cause serious neurological manifestations. We report a case of EAH presented with convulsion and drowsiness after running marathon. The patient's plasma sodium level on presentation was 119 mmol/L. He was given intravenous hypertonic saline infusion for 2 times. His conscious level improved after hypertonic saline and plasma sodium level corrected. He regained full consciousness 3 days after admission and was discharged in good condition. In this report, we reviewed the underlying pathophysiology, clinical features, risk factors, prevention measures, and treatment options of this disease entity. Early recognition of this disease entity and timely treatment with hypertonic saline is life saving.

Background

Exercise associated hyponatremia (EAH) is not uncommon and can cause serious neurological manifestations and even death. Early recognition of the diagnosis and timely treatment can be life saving. We here report a case of EAH and review the management for this disease entity.

Case Report

A 39-year-old gentleman with good past health was admitted to Princess Margaret Hospital after developing an episode of tonic clonic seizure. On the day of admission, he had been participating in a marathon run from 8:30 am till 4:30 pm. He did not have any fever, headache, neck pain, photophobia, weakness or numbness beforehand. He took an over-the-counter "Japanese medication" before the race, which was suspected to be a non-steroidal anti-inflammatory drug (NSAID). Otherwise he did not have any history of drug abuse or herbal medication consumption. He had no family or personal history of epilepsy.

On arrival at the emergency department, the patient was drowsy with Glasgow Coma Scale (GCS) of E2V1M4. His seizure had aborted spontaneously. He was normothermic with stable hemodynamics. Blood pressure was 135/75 mmHg and pulse 65/min. His spot glucose was 8.6 mmol/L. On physical examination, he was well hydrated. His pupils were equal and reactive to light and there were no focal neurological deficits or meningism. ECG and CXR were unremarkable. CT brain showed mild cerebral edema. Blood tests revealed a plasma sodium (Na) level of 119 mmol/L. His plasma potassium, urea, creatinine, and creatinine kinase were 3.4 mmol/L,

7.2 mmol/L, 85 μmol/L, and 2732 U/L respectively. Urine myoglobin was negative. White cell count was 17×10^9/L, otherwise the complete blood count and liver function tests were normal. Further workup for hyponatremia were performed. Paired plasma osmolality, urine osmolality, and spot urine sodium checked 5 hours later were 244 mmol/Kg, 580 mmol/Kg, and 46 mmol/L respectively. There were no adrenal insufficiency or hypothyroidism.

Hypertonic saline (HTS) 20 ml 5.85% sodium chloride (NaCl) in 100 ml normal saline infused intravenously over 2 hours was given for 2 times. The patient's conscious level improved as the plasma sodium level was corrected and his plasma sodium level normalized to 137 mmol/L. He regained full consciousness 3 days after admission and was subsequently discharged home on the third day.

Discussion

Incidence

Exercise associated hyponatremia is defined as hyponatremia that occurs during or up to 24 hours after physical activities, especially after endurance events [1]. It has been reported in marathons, military training, long distance hiking, and even yoga [1]. It is unheard of until 1981, as historically, runners are advised to restrict fluid intake during races [2]. After 1981, runners were advised to consume as much fluid as possible, so asymptomatic EAH is common with an incidence of 12-15% [3,4], and up to 50% among ultramarathon runners [5,6]. Symptomatic EAH is less common with incidence range from 0.1-1% [6,7], but can be as high as 38% in longer distance events [8]. Deaths are rare though, with only 14 reported in literature [7,9].

Pathophysiology

The mechanism leading to hyponatremia during exercise is mainly by dilution [7]. During exercise, fluid ingestion is driven by thirst and conditioned behavior. The abundant fluid supply during the race and the recommendation to drink in order to avoid dehydration can result in excessive fluid ingestion relative to fluid loss. The hypotonic replacement fluid results in an increase in total body water (TBW) relative to total body exchangeable sodium. Metabolism of glycogen store and triglyceride also produce free water. As a result, hyponatremia occurs due to dilution. Overhydration alone, however cannot fully explain the pathophysiology of EAH as hyponatremia can still occur in athletes who drink less than the maximum water excretion capacity [7]. This suggests that a defect in renal water excretion through an increase in antidiuretic hormone (ADH) also play a role in the development of EAH. ADH during exercise is not just stimulated by volume depletion, but also by other nonspecific stresses like physical exercise, pain, emotion, and cytokine release during muscle injury [10]. Therefore the ADH level can be inappropriately elevated during marathon running even when volume depletion is not present, resulting in hyponatremia [3]. Catecholamine and angiotensin II release during exercise may also impair the dilution capacity of the kidneys. This explained why the urine osmolality of our patient was inappropriately high.

Exchangable sodium stores also play a role in EAH. Although overhydration is a feature of EAH, 70% athletes with increased TBW did not develop hyponatremia in a study done by Noakes et al [7]. The author suggested that some people can mobilize osmotically inactive sodium from bone and cartilages so as to maintain normonatremia. EAH may develop if the body is unable to mobilize osmotically inactive sodium [7].

Overhydration is the number one risk factor for developing EAH as evident by a fall in the incidence after revising the upper limit of fluid consumption to 1-1.5 L/hour [11]. Intra-race weight gain is suggestive of overhydration. Participants with smaller body weight are also at risk as they tend to ingest more fluids relative to TBW [12]. Exercise duration of longer than 4 hours or in slow runners correlate with increased water consumption and increased sodium loss [13]. All these risk factors contribute to the development of hyponatremia in EAH. NSAID is also found to be associated with EAH in some studies by theoretically potentiating the effect of ADH [14-16]. Our patient ran for 8 hours and was suspected to have taken NSAID. He also had significant muscle injury as evident by the elevated creatinine kinase level, which might have further stimulated ADH release [10]. All these predisposed him to develop EAH.

Clinical Features

Most patients with EAH are asymptomatic or have non-specific symptoms like dizziness, nausea, and headache only. Symptoms are more likely to occur if Na <126 mmol/L, but the rate and extend of the drop in extracellular tonicity are more important determinants [1]. Severe symptoms including confusion, seizure, and altered mental state are caused by cerebral edema secondary to hyponatremia. Respiratory distress due to non-cardiogenic pulmonary edema may also occur.

Treatment

Vigilance of the diagnosis is most important. Ideally, medical facilities at endurance events should be equipped to measure serum Na. In the absence of Na level, empirical treatment should be initiated if clinically suspicious [9].

For asymptomatic patients, fluid restriction till urination is enough. If the serum Na <130 mmol/L, oral HTS with 3% NaCl 100 ml or 4 broth cubes dissolved in ½ cup water may be administered to reduce risk of progression to symptomatic EAH [9,17]. Mildly symptomatic patients should be given oral HTS [9,17,18]. Hydration with normal saline may cause further decrease in Na level if ADH level remain elevated and therefore should not be given until diuresis occur [17].

For severe symptomatic patients, HTS 3% saline 100 ml administered every 10 minutes until clinical improvement is recommended [17]. In patients with significant antidiuresis, higher dose of HTS 3-4 ml/kg/hr with administration of loop diuretics may be necessary [1]. In Hong Kong, we use 5.85% (1 mmol/ml) HTS. Since EAH develops acutely, rapid correction of hyponatremia is safe and no cases of osmotic demyelination syndrome have been reported [17].

For the prevention of EAH, recommendation by the Statement of the Third International EAH Consensus Development Conference 2015 is to drink according to thirst [9]. Using the innate thirst mechanism to guide fluid consumption should limit drinking in excess and developing hyponatremia while providing sufficient fluid to prevent excessive dehydration [9]. Measuring serial body weights during training can guide the amount of fluid replacement. Sports drinks are hypotonic fluids and will not prevent EAH in runners who overdrink, as all sports drinks have a significant lower Na level (10-38 mmol/L) than serum (~140 mmol/L) [9]. Education is the cornerstone for preventing EAH.

Timely administration of HTS is paramount in treatment of severe EAH. For those runners presenting with symptoms of severe EAH, emergent treatment with intravenous HTS is necessary and should not be delayed pending laboratory measurement of serum Na level [9]. Medical practitioners, especially medics who work at the field during endurance events should be well aware of this disease and be familiar with its treatment.

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