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Iatrogenic Water Intoxication in A Persian Cat: A Case Report

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Abstract Iatrogenic water intoxication is an uncommon emergency syndrome characterized by acute hyponatremia clinically evident by neurological signs such including nausea, vomiting, seizures, altered mentation and eventually death if not addressed. Patient's serum sodium level is keen regulatory measure for evaluating and treating acute and chronic cases of water intoxication. Present study demonstrates a cat patient in which subcutaneous administration of 5% dextrose in water to compensate body fluid deficits further detoriate the illness and induced neurological signs. Cat was treated with on-hand 0.9% NaCl solution to equilibrate sodium at an appropriate level in intracellular and extracellular spaces. The selection of fluid as supplemental therapy is very critical keeping in view the condition of patient, as it can exaggerate ailment by interrupting vital functions rather than rehabilitating from illness.

Keywords Hyponatremia; Subcutaneous; 5% dextrose; 0.9% NaCl

Background

Iatrogenic water intoxication diversely recognized as acute dilutional hyponatremia and cold water hemoglobinuria, is less known but very important regarding supportive care (Harvey, 1936; Hannan, 1965; Lawrence, 1965; Kirkbride and Frey, 1967). This condition is caused by severe hyponatremia clinically characterized by the lethargy, nausea, vomiting, seizures, respiratory distress and death (Manning, 2001). Neurological signs usually appear when sodium (Na) level falls down the critical value of < 130 mmol/L (Schaer, 1999). It has been well described in calves (Jones, 1936; Hannan, 1965), camels (Waitumbi and Connor, 1987) and sheep (Abdelrahim et al., 1985). In humans, most cases are autogenic associated with voluntarily excessive water intake, exuberant marathon races, inadequate electrolyte intake (Draper et al., 2009), undue sodium loss and with laboratory volunteers for urine drug testing (Klonoff and Jurow, 1991). In animals, it occurs on availability of bulk quantity water after prolong thirsty period leading to low serum osmolarity, blocking the release of antidiuretic hormone (ADH) and thus excrete more dilute urine. Water shifts from extracellular space of cerebro-spinal fluid (CSF) into intracellular spaces of brain cells leads to the development of cerebral edema and consequently neurological signs are observed (Adrogué and Madias, 2000). There is no age, breed and sex predilection to this condition, however chronic dehydration, fever, diarrhea, strenuous exercises, prolonged limited availability of water and increased environmental temperatures are the important predisposing factors (Lawrence, 1965).

Sodium (Na) concentration is also closely associated with water contents of the body. Keeping in view the existing status of the body fluid, hyponatremic patients can be further categorized into normovolaemic, hypovolaemic and hypervolaemic. Furthermore, the onset of the malady may help to categories hyponatraemia into acute or chronic in order to provide appropriate treatment. Acute diarrhea, vomiting, addison's disease, and severe burns are the conditions associated with hypovolemic hyponatremia (Schaer, 1999).

Prompt rectification of hyponatremia should be ensured to avoid further neurological complications such as cerebral injuries, however onset rate should be assessed by careful history evalution and physical examination, as very fast treatment of chronic hyponatremia may lead to osmotic myelinolysis (Churcher et al., 1999). In cats and dogs, like humans, mismanagement in diuretic and anti-diuretic medications and excessive parental hypotonic fluid administration are well recognized iatrogenic causes (Manning, 2001).

1 Case Presentation

A 1 year old intact female Persian cat, weighing about 2 kg was referred to Veterinary Medical Teaching Hospital (VMTH) University of Agriculture Faisalabad, Pakistan for the treatment of severe anorexia, depression, lethargy and occasionally partial seizures. The patient was evaluated by the referring veterinarian 16 hours prior to presentation at VMTH for intermittent vomiting, anorexia and mild lethargy. The results of hematology (CBC) and sero-biochemical analysis revealed mild elevation in serum albumin (4.1 g/dL; reference value: 2.8-3.9 g/dL), total protein (8.5 g/dL; reference value: 6.0-7.9 g/dL), glucose (180 mg/dL; reference value: 60-120 mg/dL) and potassium (8.9 mEq/L; reference value: 3.7-6.1 mEq/L). The concentration of serum sodium was also within normal reference range (150 mEq/L). The cat was treated as an outdoor patient with a single subcutaneously (SC) administered bolus (approximately 350 ml) of 5% dextrose in water (D5W®). The guardian was advised to monitor the patient for next 24 hours for progression of clinical signs. The cat lived only an indoor lifestyle and was fed with commercially available cat food. However, a recent change in diet by substituting cat food with chicken meat was also recorded. Parasitic control program consisted of pyrantel pamoate (Zentel®). Vaccination of the cat was recent and included those against feline rhinotracheitis virus, calicivirus, panleucopenia virus, chlamydia psittaci and feline leukaemia virus (Fel-O-Vac 5®). On admission to VMTH, a complete physical examination documented hypothermia (37 ℃), tachypnea (60 breaths/minute), tachycardia (190 beats/minute), slightly increased capillary refill time (CRT > 3 second) and skin turgor. The cat was dull and trembling with intermittent seizures having pink and tacky oral mucous membranes. Urination and defection were normal. A mild S/C edema indicating the site of fluid administration was observed at dorsal aspect of neck. A complete neurological examination yielded positive pupillary light, corneal, palpebral, oculocephalic, gag, spinal, cranial and withdrawal reflexes. The cat was admitted for in-house routine clinical and laboratory investigation. The results were including marked hyponatremia (70 mEq/L; reference range: 146-156 mEq/L), hyperglycemia (170 mg/dL; reference value: 60-120 mg/dL), hypperalbuminemia (4.2 g/dL; reference value: 2.8-3.9 g/dL), hyperproteinemia (8.7 g/dL; reference value: 6.0-7.9 g/dL) and mild concentrated urine (specific gravity = 0.921; reference value: 1.020-1.040). A presumptive diagnosis of iatrogenic water intoxication due to hyponatremia following SC administration of D5W was arrived.

The Na deficit was determined on the basis of following formula [desired alteration in Na concentration x (0.6 x body weight in kg)]. Treatment consisting IV administration of 80 ml (40 ml/kg b.wt) of 0.9% NaCl followed by a continuous rate infusion of 0.9% NaCl (60 ml/kg/d) along with ranitidine (Injection Zentac® 1 mg/kg b.wt; IV; q12h) and metoclopramide (Injection Maxilon® 1 mg/kg b.wt; IV; q12 h). The patient was shifted near an artificial heating lamp until the restoration of normal body temperature. After 12 hours of the treatment, mild improvement in the level of serum Na (70 mEq/L) was noticed. Cardinal parameters including temperature respiration and heart rate were within normal reference range. Nevertheless partial seizures, muscle twitching and vomiting (one episode) were still recorded. After next 8 hours, along with increasing Na concentration, cat's mentation progressively improved and paresis diminished. After 48 hours from the presentation, the neurological status of the cat was improved and the patient was completely normal. Laboratory findings including serum Na were within normal reference range. The cat was discharged and guardian was advised to pursue additional diagnostics for sporadic vomiting if required. Three days after discharge, cat was mentally apposite without any neurological deficits.

2 Discussions

Among electrolytes, Na is the chief extracellular cation present in the body having a vital role in maintaining water homeostasis. Dilutional hyponatremia caused by excessive water accumulation in body having characteristic feature of hypotonicity, hyposmolarity and hypervolemia. However, few reports of this malady can be traced back in felines and canine (Toll et al., 1999; Evenchen et al., 2010; Lee et al., 2013). This form of hyponatremia usually develops when the amount of water exceeds the capacity of kidneys to filter and excrete even after the suppression of ADH (Adrogué and Madias, 2000). The commercially available 5% dextrose solutions intend to use as veterinary medical infusion is an isomolar (containing dextrose 252 mosm/ L). After administration, glucose becomes rapidly absorbed and fluid becomes significant hypotonic that can induce either

dilutional hyponatremia or natriuresis as a consequence of hyperglycemia (Holliday et al. 2004). Subcutaneous route is usually regarded as body's third compartment which strictly obeys the rules of diffusion for movement of solutes and solvents. Glucose present in fluid is partially utilized by the cells and remaining glucose diffuses (from higher concentration gradient) to intravascular (low concentration gradient) compartment resulting in hyperglycemia. Excessive water of administered solutions also follows the osmotic concentration gradient and dilutes the blood electrolytes hence leading to hyponatremia (Stockham and Scott, 2002). Moreover, the low concentration of electrolytes in the fluid administered subcutaneously can draw out more electrolytes from intracellular and extracellular fluid and transfer into subcutaneous space (DiBartola and Bateman, 2006). These mechanisms were causative for the development of acute hyponatremia. In addition, sudden diet alteration and vomiting were the predisposing factors observed in our presenting case.

In veterinary patients, this condition was also observed after ad-libitum access of fresh water to a group of young calves just after weaning (Gilchrist, 1996). Among dogs, this was observed after consumption of a large volume of lake water (Toll et al., 1999). In the presenting cat, neurological abnormalities appeared as ramification of developing hyponatremia which become more complicated after hypodermoclysis of low electrolyte solution. Injecting this solution leads to acute hyposmolarity resulting in cerebral edema and acute hemolytic anemia because of brain cell swelling and RBC's lysis.

During ruling out among differential diagnosis, transurethral resection of the prostate (TURP) and syndrome of inappropriate antidiuretic hormone (SIADH) were taken into account. TURP is surgical manipulation which highly risks water intoxication post-surgically. SIADH is common in humans suffering from multiple tumors (Talmi et al., 1992; Sorensen et al., 1995), however evaluation of patient's anamnesis didn't bring out any associated tumor and surgical manipulation. Furthermore, urinanalysis of cat didn't reveal any significant changes as the patients of SIADH are usually characterized by more concentrated and less volume urine (Dibartola, 2012). Various treatments have been mentioned in the literature including the use of diuretics (Hahn, 1989; Crowley et al., 1990). In our treatment regime, we averted mannitol keeping in view the condition of patient as it may worsen the situation in the form of acute fluid overload. We also avoided the use of furosemide as it also losses some sodium via kidneys. Keeping in mind, the fact that rapid recovery rate of chronic hyponatremia may prompt the development of osmotic demyelination syndrome (Polzin, 2011) the patient was administered 1.5% saline solution according to body weight over 48 hour period of time.

Hypodermoclysis is a safe technique for rehydration in mildly dehydrated veterinary patients and mostly used in geriatric patients (Slesak et al., 2003) but balanced electrolyte composition (200-400 mOsm/kg) of solution should be monitored. About 50-200 ml volumes per site can be injected safely (Schaer, 1989; Crowley et al., 1990). In patients requiring rapid or large volume of fluid administration such as in shock or burns, this technique is of limited use (Hansen, 2006). Concerning its composition a large volume bolus of dextrose 5% as a single fluid is contraindicated to use in cats (Crowley et al., 1990; Hansen, 2006). This infusion can be used in combination with 0.9% NaCl or with 0.45% NaCl, however the volume and rate of infusion should be in range of 75-150 ml/hour (Junior et al., 2000).

Prevention of this iatrogenic complication include the awareness among veterinary technicians about careful management of electrolyte composition along with fluid therapy, if neglected it can further deteriorate the condition of patients. At the same time, this supportive plan can rehabilitate the sick patients if cautiously monitored.

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