

C A S E R E P O R T

Severe hypokalemia and hypophosphatemia presenting with carpopedal spasm associated with rhabdomyolysis

Valentina Fainardi¹, Aderville Cabassi², Nicola Carano¹, Rossana Rocco², Enrico Fiaccadori², Giuseppe Regolisti², Icilio Dodi¹, Carmine Del Rossi³.

¹Paediatrics Unit, Dipartimento di Medicina Clinica e Sperimentale, Az. Ospedaliero-Universitaria, Parma, Italy; ²Cardiorenal Research Unit, Dipartimento di Medicina Clinica e Sperimentale, Az. Ospedaliero-Universitaria, Parma, Italy; ³Pediatric Surgery Unit, Dipartimento di Medicina Clinica e Sperimentale, Az. Ospedaliero-Universitaria, Parma, Italy

Summary. *Background* Severe hypokalemia, defined as serum potassium < 2.5 mEq/L, may lead to neuromuscular, gastrointestinal, and ECG abnormalities. Neuromuscular consequences of hypokalemia include weakness, cramps, rarely paralysis, eventually progressing to rhabdomyolysis. *Case presentation* We report a case of a 4-year-old girl presenting carpopedal spasm and rhabdomyolysis due to severe hypokalemia associated to hypophosphatemia and hypovolemia. At one month of age she underwent an ileal resection because of a neonatal necrotizing enterocolitis, and a bowel resection at two years of age, because of sub-occlusive episodes. The child had frequent episodes of diarrhoea and was treated with oral white clay (kaolin) and a restrictive diet. Three days prior the admission to the hospital she had numerous episodes of watery diarrhoea. Laboratory tests revealed severe hypokalemia, hypophosphatemia, normal calcium levels associated with marked dehydration. An ECG demonstrated sinus bradycardia, ST-segment depression, T-wave flattening, U-wave, and long-QTc. Symmetric carpal and pedal spasms were observed. A marked rise of creatinine phosphokinase and myoglobin associated to cola colored urine was observed. Intravenous supplementation of potassium phosphate as well as adequate volume repletion led to an improvement of the clinical condition, to the disappearance of carpal and pedal spasms, to normalisation of ECG. *Conclusions* Careful electrolytes and volume supplementation led to the correction of potential life-threatening arrhythmias and obtained a complete recovery from carpopedal spasm and rhabdomyolysis. Dietary restriction and pharmacological preparations as kaolin have to be administered with caution to treat diarrhea in children and particularly in those who may present other pre-existing risk factors.

Key words: Hypokalemia, hypophosphoremia, rhabdomyolysis, carpopedal spasm, kaolin

Introduction

Severe hypokalemia is defined as serum potassium less than 2.5 mEq/L. Hypokalemia can be caused either by inadequate intake or by potassium loss which can be due to renal or extra-renal causes. The most common causes of hypokalemia in children are gastrointestinal losses due to vomiting and diarrhea (1). Reduced potassium concentration especially if persistent may lead to neuromuscular, gastrointestinal, and ECG abnormalities. Neuromuscular consequences

of hypokalemia include weakness, cramps, rarely paralysis, eventually progressing to rhabdomyolysis (2). Hypokalemia can lead to a series of ECG alterations such as depression of ST segment, T wave flattening and prolonged QTc interval, prominent U wave with potential development of life-threatening arrhythmias.

We report here a case of a 4-year-old girl presenting carpopedal spasm and rhabdomyolysis due to severe hypokalemia associated to hypophosphatemia and hypovolemia.

Report

A 4-year-old girl was referred to our hospital for severe hypokalaemia (1.4 mEq/L, NR 3.5-5.3) from a secondary care centre. Her past medical history denoted ileal resection due to neonatal necrotizing enterocolitis at one month of age. She did not suffer from short bowel syndrome but she experienced several sub-occlusive episodes likely due to sigmoid dolichocolon which was successfully resected at the age of 2. There was no family history of hypokalemic periodic paralysis, neuromuscular, renal or metabolic disease.

Four months before admission, following a course of antibiotic, the child had frequent episodes of diarrhoea. In an attempt to regularize her stools, she was treated with oral white clay (kaolin 1.5 g/day) and with a restrictive diet including rice, pasta, vegetable oil, and parmesan cheese. Neither fruit nor vegetables were allowed; multivitamin-multimineral nutritional supplements were administered daily. Blood tests obtained before starting the suggested diet were normal. Stool consistency slightly improved.

Three days prior to admission to the hospital the patient had watery diarrhoea (up to 10 episodes in 24 hours; no blood or mucus were reported), vomiting, asthenia, myalgia, and polyuria. At the admission, physical examination showed severe dehydration, hypotension, and marked asthenia. Laboratory tests revealed severe hypokalemia (1.3 mEq/L), metabolic alkalosis (pH 7.51, pCO₂ 46 mmHg, HCO₃ 33.5 mEq/L), severe hypophosphatemia (1.7 mg/dl, NR 2.5-6.5) and low chloride levels (93 mEq/L, NR 96-112). Within the normal range were the other electrolytes including sodium, calcium, and magnesium. An ECG demonstrated sinus bradycardia (64 beats/min), anteroseptal ST segment depression, T wave flattening, U wave, and long QTc 569 msec (Figure 1).

An immediate supplementation was started using intravenous glucosaline (0.9% NaCl and glucose 5%) and potassium (as phosphate and chloride salts for a total amount of 7 mEq/kg/day). Intravenous potassium canrenoate was also administered twice a day. Kaolin treatment was discontinued and a normal diet introduced. After 36 hours, the child was transferred to our tertiary hospital. Upon admission physical examination confirmed moderate dehydration, abdomen dis-

tension with no tenderness, and symmetric carpal and pedal spasms. Body weight was 15 kg (10th percentile on the growth chart). Blood pressure was 68/30 mmHg in clinostatism, pulse rate 100 beats/min, and body temperature was 35.8°C. At the ECG flat T waves were still present. Laboratory parameters showed normal serum electrolytes, marked rise of creatinine phosphokinase (CPK) (3.773 U/L, NR 0-200), and elevated values of myoglobin (314 ng/ml, NR 0-4), LDH (5.236 U/L, NR 250-500), AST (1.581 U/L, NR 0-40), and ALT (780 U/L, NR 0-40). Urine was cola colored suggestive of myoglobinuria. These findings were indicative of massive rhabdomyolysis, confirmed by the peak of CPK to 43.866 U/L twelve hours after the admission. In Figure 1 is depicted the time course of CPK, along with potassium and phosphate serum levels during the following days.

Hence, intravenous volume expansion and potassium salts replacement were continued and, suspecting a bacterial-related diarrhea, intravenous metronidazole was started. Thyroid and parathyroid dysfunction, celiac disease, and vitamin D deficiency were excluded; no abnormalities were found at the abdominal ultrasound. Plasma renin activity (PRA) and aldosterone levels were also evaluated to exclude adrenal involvement in the hypokalemia. The results were suggestive for volume depletion (PRA 35.95 ng/ml/h, NR 0.2-2.8; aldosterone 658 pg/ml, NR 29-162). Stool specimen resulted positive for Norovirus.

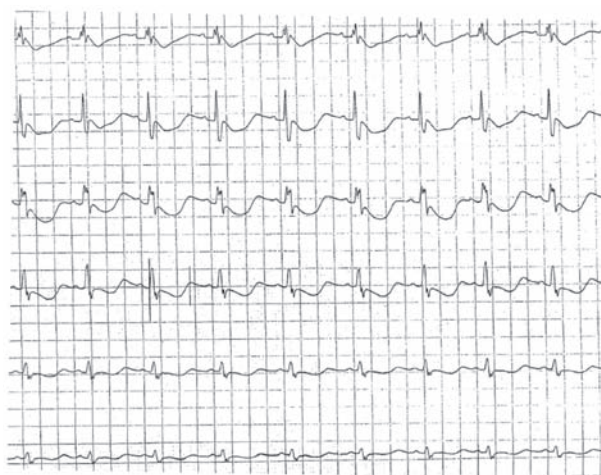


Figure 1. ECG at hospital admission.

In the following days a progressive improvement of the clinical condition was observed, carpal and pedal spasms disappeared, and ECG returned normal. Electrolytes remained within the normal range and CPK values progressively declined (Figure 2). She was discharged after 9 days.

Discussion

Our clinical case shows a young girl with carpopedal spasm and rhabdomyolysis induced by severe hypokalemia associated to hypophosphatemia.

Carpopedal spasm is usually described in hypocalcemia-related tetany, rarely in congenital renal wasting of potassium and magnesium (3,4) or during metabolic alkalosis (5), and never in hypokalemia or hypophosphatemia due to malnutrition or intestinal infection. On the other hand, severe chronic potassium and phosphorus depletion have been linked to the development of rhabdomyolysis. Rhabdomyolysis in fact has been reported in patients with diarrhea, vomiting, diuretics and laxatives abuse, excess of licorice intake, chronic alcohol abuse, short bowel syndrome, severe malnutrition, neuroendocrine pancreatic tumor, and congenital tubular disorders such as renal tubular acidosis, Bartter or Gitelman syndromes (2,6).

Potassium regulates skeletal muscle arterial flow and vascular tone and its severe depletion may sustain local ischemia and muscular damage. Furthermore, when severe hypokalemia is combined to hypophosphatemia, myocyte injury and rhabdomyolysis can be further facili-

tated because of adenosine triphosphate (ATP) reduction which is associated to mitochondrial dysfunction and oxygen radical production (2).

Multiple physiopathological mechanisms contribute to the carpopedal spasm and rhabdomyolysis observed in our clinical case. Low serum potassium levels and hypovolemia were associated to metabolic alkalosis and hypochloremia. Hypovolemia was likely due to the association of vomitus and diarrhea, as the findings of high levels of renin and aldosterone confirmed, but hypochloremia was mainly related to the gastric losses. Metabolic alkalosis was related to increased renal bicarbonate reabsorption, due to the intracellular acidosis related to hypokalemia, and to volume/chloride depletion. Other causes of hypokalemia, hypovolemia, and metabolic alkalosis were excluded, in particular Bartter or Gitelman's syndromes because 24-hour urinary calcium excretion as well as serum magnesium concentration were within the normal range. Moreover, because carpopedal spasm has been described in early phase of celiac disease (7) and in thyrotoxicosis (8), serology for tissue transglutaminase, endomysium antibodies, and thyroid hormones were checked resulting negative.

Since potassium is mostly intracellular, its serum concentration is not an accurate marker of potassium body pool content and when serum potassium decrease, a severe intracellular loss has already occurred. It must also be considered that in our case the presence of rhabdomyolysis may have falsely increased serum potassium level. Thus, the main objective of the treatment of severe hypokalemia is the rapid rise of serum potassium concentration in order to avoid life-threatening arrhythmias and to replace the body pool potassium deficit. According to the formula that serum potassium concentration approximately falls by 0.3 mEq/L when the body store loses 100 mEq, our patient had a potassium deficit of about 1200 mEq. After intravenous infusion of 960 mEq of potassium salts (both chloride and phosphate) during a period of 48 hours, potassium level reached 3.0 mmol/L.

Severe hypokalemia is rarely due to dietary restriction (2) or clay ingestion (9) alone. In the present case, a mild hypokalemia may have developed after months of chronic dietary potassium deficiency and regular kaolin assumption, a clay-like powder used to improve stool consistency by fluids absorption. The acute potassium loss induced by Norovirus gastroenteritis precipi-

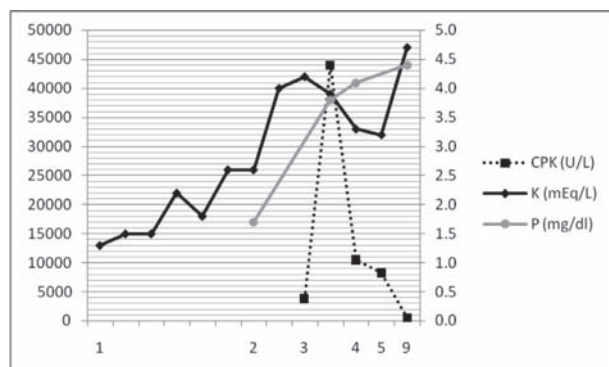


Figure 2. Potassium (K), phosphate (P) and serum creatine phosphokinase (CPK) time course during the hospital stay.

tated this pre-existing condition. In addition, our patient underwent an ileal resection during infancy and such a condition may have facilitated diarrhea episodes after the antibiotic treatment.

Conclusion

From a detailed clinical history, a prompt diagnosis, electrolytes and volume supplementation we prevented potential life-threatening arrhythmias and obtained a complete recovery from carpopedal spasm and rhabdomyolysis. Dietary restriction and pharmacological preparations as kaolin have to be administered with caution to treat diarrhea in children (10) and particularly in those who may present other pre-existing risk factors.

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Correspondence:

Aderville Cabassi, MD

Unità di Ricerca Cardio-renale, Dipartimento di Medicina Clinica e Sperimentale, Università degli Studi di Parma, Az. Ospedaliero-Universitaria di Parma

Via Gramsci 14, 43100 Parma,

Phone+39 0521 033191; fax +39 0521 033185

E-mail: aderville.cabassi@unipr.it