Case Report

Transient Hyperkalemic Distal Renal Tubular Acidosis with Bicarbonate Wasting in a Young Child

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Distal renal tubular acidosis is a clinical syndrome characterized by inability to acidify urine in the presence of metabolic acidosis. Classic dRTA patients exhibit failure to thrive, polyuria, metabolic acidosis and hypokalemia. Hyperkalemic dRTA without underlying disease is very rare. Transient bicarbonate wasting accompanied with hypokalemic dRTA was reported in infants. Herein, a transient hyperkalemic dRTA with bicarbonate wasting was reported in a young child.

Keywords: *Transient, Proximal tubular bicarbonate wasting, Hyperkalemic, Distal renal tubular acidosis, Renal tubular acidosis type 1, Malnourished child*

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Distal renal tubular acidosis (dRTA) is a rare condition characterized by the inability to lower the urine pH maximally in the face of moderate to severe metabolic acidosis[1-3]. Classic dRTA patients exhibit polyuria, hypokalemia, metabolic acidosis, and nephrocalcinosis[1-3]. Hyperkalemic dRTA without underlying disease was rarely reported. In children, dRTA is almost always observed as a primary entity. It may be observed as sporadically or with mutations of the anion exchanger (AE1)[4] and a subunit (ATP6V1B1) of proton pumps[5]. Almost one third of infantile dRTA patients in Thailand has unknown etiology[6]. Most patients with primary infantile dRTA usually required life-long alkali therapy[7]. Herein, the author report a rare condition, transient hyperkalemic dRTA with bicarbonate wasting, in a young child.

Case Report

A 2-month-old female infant presented with failure to thrive. She was born with a birth weight of 3.3 kilograms and had received rice water and banana since birth. She was the third child of a 42-year-old mother. The prenatal serology for HIV, hepatitis B virus and syphilis were negative. Parents and siblings were healthy. Consanguinity, growth retardation, and renal or bone diseases were notably absent from the family history. Physical exam noted blood pressure of 65/40 mmHg, respiratory rate 40/min, heart rate 130/min, temperature 37°C, height 53 cm, weight 3.2 kilograms, head circumference 34 cm, apathy, dry lips, swollen and redness of left periorbital area. She had dry and scaly skin, erythrematous maculopapular rash at perianal area, and pitting edema at both legs. Hypotonia of all extremities with motor power grade 4 of 5 and normal deep tendon reflex were documented. Initial investigation showed; Hct 35.0%, MCV 96.2 fL, WBC 16,700 cells/mm^2, neutrophil 25%, lymphocyte 75%, platelets 320,000 cells/mm^2, reticulocyte count 0.6%. Her peripheral blood smear showed normal red cell morphology with few microcytes and hypochromia. Serum chemistry showed Na 142 mEq/L, K 6.1 mEq/L, Cl 111 mEq/L, HCO_3 15.4 mEq/L, Ca 8.5 mg/dL, P 6.0 mg/dl, Mg 1.9 mg/dL, blood urea nitrogen 2 mg/dL, creatinine 0.5 mg/dL, glucose 110 mg/dL, serum total protein 4 gm/dL, albumin 2 gm/dL, total bilirubin 0.42 mg/dL, direct bilirubin 0.08 mg/dL, ALT 60 u/L, ASO 164 u/L, alkaline phosphatase 251 u/L. Urinalysis revealed specific gravity of 1.005, negative for protein, sugar or cells. She was diagnosed as marasmic kwashiorkor, iron deficiency anemia, left periorbital cellulitis and mild dehydration. Metabolic acidosis with normal anion gap of 15.4 and inability to concentrate urine were detected. The patient received infant formula, ferrous sulfate and multivitamin to improve her nutrition status. A 10 days course of intravenous cloxacillin and gentamicin was given for periorbital infection.

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Two days after admission, she became well hydrated after initial treatment with serum Na 130 mEq/L, K 5.2 mEq/L, Cl 100 mEq/L, HCO_3 16.4 mEq/L, BUN 7 mg/dL, Cr 0.3 mg/dL. Her blood chemistry was repeated on day 4 and she remained acidosis with normal anion gap. Renal tubular acidosis was suspected due to persistent normal anion gap metabolic acidosis without diarrhea. To evaluate serum K level and prevent the possibility of hypokalemia due to re-feeding syndrome, serum chemistry was re-evaluated at 2 weeks later and showed Na 141 mEq/L, K 6.9 mEq/L, Cl 109 mEq/L, HCO_3 14.6 mEq/L. Urine was collected under mineral oil to measure urine pH and chemistry. Urine pH was 6.8 by a mean of pH meter with electrode. Urine chemistry showed Na 10 mEq/L, K 10.5 mEq/L, Cl 17 mEq/L. Calculated urine anion gap was 3.5. Urine net acid excretion was 34 mEq/24 h/1.73m^2 (normal > 70 mEq/1.73m^2/24 hr). Tubular reabsorbtion of phosphate was 89% (normal > 85%). Urine calcium/creatinine ratio was 0.5 (normal < 0.86). Urine flow rate was 3.5 ml/kg/h. Creatinine clearance was 36 ml/min/1.73m^2. Serum and urine osmolality were 294 and 180 mOsmol/kg.H_2O, respectively. Serum renin was 4.07 ng/ml/h (normal 0.2-2.8 ng/ml/h). Serum aldosterone was 36 ng/dL (normal 5-90 ng/dL). The bicarbonate excretion was evaluated after sodium bicarbonate loading. Urine fractional excretion of HCO_3 was 10% while she was non acidotic. Renal ultrasonography demonstrated normal size, appearance, and echogenicity of both kidneys. Urinary bladder and both ureters appeared normal. Therefore, a diagnosis of hyperkalemic dRTA with bicarbonate wasting was given. Eighteen mEq/kg/day of alkaline from shohl's solution was able to normalize her serum HCO_3 from 14.6 to 22 mEq/L. Serum K became lower from 6.9 to 5 mEq/L. The patient gradually gained weight with infant formula and alkaline therapy. At the age of 2.5 years, she was diagnosed as bilateral sensory neural hearing loss and was on hearing aids. She has now been under follow-up for 6 years with normal growth. The requirement of alkaline therapy was gradually decreased to maintained normal serum HCO_3 (Table 1). At the age of 6, her serum HCO_3 was 24 mEq/L without alkaline therapy.

Discussion

Renal tubular acidosis is a rare biochemical syndrome characterized by minimal or absent azothemia and hyperchloremic metabolic acidosis. This patient was diagnosed as hyperkalemic dRTA because of a persistently high urine pH during severe metabolic acidosis and inability to excrete urinary tritable acid and ammonium. The patient was not categorized as type-4 RTA with hyperkalemia because of inability to acidify urine while severe metabolic acidosis. The patient initially required a high dose of bicarbonate to normalize serum HCO_3 levels. The fractional excretion of bicarbonate was 10% while non acidosis indicating proximal bicarbonate wasting in this patient. The requirement of bicarbonate was high during the first two and a half year of life. Then, it decreased to 3-4 mEq/kg/day during the later 2 years. Therefore, dRTA with infantile renal bicarbonate wasting was diagnosed in this patient. This rare clinical syndrome had been demonstrated since last 40-50 years[1,2,8,9]. However, those reported patients had classical dRTA with hypokalemia or normokalemia. Although, hyperkalemic dRTA was reported by Batlle et al but their patients had dRTA secondary to other renal parenchymal diseases[10]. To date, However, no patient was reported a complete recovery from this particular clinical finding. To the best of my knowledge, this is the first patient of hyperkalemic dRTA with infantile renal bicarbonate wasting with spontaneous recovery.

The common causes of hyperkalemic dRTA including drugs and obstructive uropathy were not identified in this patient. Interestingly, hyperkalemic dRTA was diagnosed in this patient with marasmic kwashiorkor. Previous study in malnourished children demonstrated impairment of renal acid excretion after NH_4Cl loading[11]. However, these malnourished children did not have renal tubular acidosis[11]. In addition, the present patient had required bicarbonate therapy for many years after improvement of malnutrition. Thus, marasmic kwashiorkor should be a coincidence rather than a cause of dRTA in this patient. Sensorineural hearing loss have been associated with dRTA due to mutations in a subunit (ATP6V1B1) of the proton pump in alpha intercalated cell of renal collecting duct and inner ear[5,12]. The patients with these mutations have a permanent dRTA. The present patient had transient dRTA which was incompatible with this clinical entity. The mechanism of transient hyperkalemic dRTA with bicarbonate wasting in the present patient remains unknown. Batlle D et al demonstrated impaired H^+ and K^+ excretion in collecting tubule of patients with hyperkalemic dRTA[10]. Inability of lower urine pH and subnormal K^+ excretion were demonstrated after administration of furosemide known for increasing distal Na reabsorption. Thus, impaired distal Na reabsorption or voltage dependent acidification defect in the cortical collecting tubule may be an underlying mechanism of hyperkalemic dRTA[10]. The mechanism

Table 1. Serial anthropometric measurement, laboratory data, and alkaline therapy

	2 month-old admission	6 month-old	1 year-old	2 year-old	3 year-old	4 year-old	5 year-old
Body weight (kg) (%)	3.2 (3)	6.3 (25)	8.5 (50)	11 (40)	12.5 (40)	17 (50)	18 (60)
Height (cm) (%)	53 (< 3)	62 (15)	70.5 (15)	82 (25)	87 (25)	90 (25)	105 (30)
Serum Na (mEq/L)	142	135	138	133	138	138	140
Serum K (mEq/L)	6.1	5.6	5.1	4.3	4.1	4.1	4.1
Serum Cl (mEq/L)	111	102	101	98	104	102	100
Serum HCO_3 (mEq/L)	15.4	24.5	21	20	23.5	24.7	24
Serum albumin (g/dL)	2.0	3.0	3.5	4.0	4.0	4.0	4.0
Urine Ca/creatinine (mg/mg)	0.5	0.2	0.2	0.2	0.2	0.03	0.01
Alkaline therapy(mEq of HCO_3 /kg/day)	-	20	17	18	3	2	0.4

Abbreviation: %; percentile for age among Thai children

of infantile bicarbonate wasting remains unknown. Functional immaturity of proximal tubules may contribute to this finding[2]. Similar to previous reports[1,2,7], bicarbonate wasting in this patient improved in first few years of life.

In summary, this is the first case report of transient hyperkalemic dRTA with bicarbonate wasting in a young child. This case report should expand the list of dRTA in children.

Potential conflicts of interest

None.

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รายงานผู้ป่วยเด็กที่มีภาวะ distal renal tubular acidosis ชนิดที่มีโปแตสเซียมสูงและหายเอง

สุขเกษม โฆษิตเศรษฐ

ภาวะ distal renal tubular acidosis เป็นภาวะความผิดปกติของท่อไต ส่วนปลายในการทำปัสสาวะให้เป็นกรดในขณะที่เลือดมีภาวะเป็นกรด ผู้ป่วยมักมีลักษณะเลี้ยงไม่โต ปัสสาวะมากเลือดมีภาวะเป็นกรด และระดับโปแตสเซียมในเลือดต่ำ สำหรับภาวะที่มีระดับโปแตสเซียมในเลือดต่ำร่วมกับภาวะ distal renal tubular acidosis พบได้น้อยมาก ในขณะที่การสูญเสียไบคาร์บอเนตทางไตพบได้ชั่วคราวในเด็กแรกเกิดซึ่งจะพบร่วมกับภาวะ distal renal tubular acidosis ชนิดที่มีโปแตสเซียมในเลือดต่ำ รายงานนี้แสดงภาวะ distal renal tubular acidosis ที่มีภาวะโปแตสเซียมในเลือดต่ำร่วมกับภาวะสูญเสียไบคาร์บอเนตในปัสสาวะที่หายเองในเด็กเล็ก