Reversible Dilated Cardiomyopathy Due to Combination of Vitamin D–Deficient Rickets and Primary Hypomagnesemia in an 11-Month-Old Infant

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Abstract

Keywords

- rickets
- dilated cardiomyopathy
- hypomagnesemia

Vitamin D–deficient rickets is still an important and common health problem in developing countries. Since calcium is an essential ion for cardiac muscle contraction, calcium deficiency caused by rickets can cause secondary dilated cardiomyopathy. This situation can be exacerbated by coexisting hypomagnesemia. Here, we report a case of dilated cardiomyopathy due to hypocalcemia induced by vitamin D–deficient rickets and accompanying primary hypomagnesemia in an infant whose cardiomyopathy was successfully treated by replacement of calcium, vitamin D, and magnesium. In addition to genetic causes, viral infections, and idiopathic factors, metabolic abnormalities are important etiologic factors in pathogenesis of dilated cardiomyopathy and since they are treatable, prompt diagnosis of these disorders is crucial.

Introduction

Dilated cardiomyopathy (DC), defined as the left ventricular dilatation and systolic dysfunction, is one of the most common causes of heart failure in children. The etiology of DC includes genetic causes, metabolic diseases, viral infections, or unknown reasons that are considered as idiopathic.¹ Hypocalcemia is an extremely rare cause of DC,² and vitamin D–deficient rickets is still a frequent common health problem in developing countries. Since calcium is an essential ion for the contraction of cardiac muscles, prompt diagnosis and replacement of calcium and vitamin D may reverse hypocalcemia induced life-threatening DC. Therefore, clinically it is important to distinguish this rare and treatable cause of DC. In this case, we report DC due to hypocalcemia

induced by vitamin D–deficient rickets and accompanying primary hypomagnesemia in an infant whose cardiomyopathy was successfully treated by replacement of calcium, vitamin D, and magnesium.

Case Report

An 11-month-old boy was admitted to the local hospital with complaints of fever, cough, respiratory distress, and head sweating. He was diagnosed with pneumonia and administered intravenous antibiotic treatment. During the treatment period, tachypnea and oxygen therapy developed. Echocardiological evaluation showed an ejection fraction (EF) that was 36%. Based on the decreased EF and the history of an upper respiratory tract infection, he was diagnosed

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with viral myocarditis. He received 1 g/kg intravenous immunoglobulin (IgG) for 2 days. After IgG therapy, severe hypocalcemia was detected and the cardiomyopathy had not improved. Therefore, he was intubated and referred to our hospital for ongoing care.

On physical examination, he had a large anterior fontanelle, a 2/6 pansystolic murmur, crackles on both middle lung fields, and a rachitic rosary. His body weight was 11 kg (50–75th percentile), his height was 75 cm (50th percentile), and his head circumference was 45 cm (50th percentile). His blood pressure was 90/50 mm Hg. He was born after 40 weeks of gestation by an uneventful vaginal delivery. His birth weight was 3.4 kg. He was exclusively breast-fed and had not been given vitamin D supplements. His parents were first cousins.

Laboratory investigation showed hemoglobin, 11.2 g/dL; hematocrit, 30.2%; white blood count, $9.6 \times 10^3 \mu\text{g/L}$; thrombocyte, $473 \times 10^3 \mu\text{g/L}$; Na/K, 138/3.8 mEq/L; glucose, 130 mg/dL; BUN/creatinine, 10.6/0.4 mg/dL; and albumin, 4.5 mg/dL. All vitamin D related laboratory parameters before and after the treatment are shown in ►Table 1. Total serum calcium, ionized calcium, magnesium, and 25-hydroxyvitamin D levels were lower than the normal limits; however, phosphorus, alkaline phosphatase (ALP), parathormone (PTH), and brain natriuretic peptide (BNP) levels were higher than the normal limits. Chest radiography showed cardiomegaly and pulmonary congestion. On left-hand wrist X-ray, features of active rickets were observed (►Fig. 1). On electrocardiography, a prolonged corrected QT interval (QTc; 0.52 second) was detected. Holter monitoring was normal. He had no family history of prolonged QTc syndromes. Prolonged QTc was explained by hypomagnesemia. Cardiac enzymes were within the normal limits. Echocardiography revealed impaired left ventricular systolic function with an EF of 35%. Left ventricular end diastolic diameter (LVEDD) was 39 mm and contraction function was 16%, demonstrating ventricular dilatation. The screening of other metabolic parameters, such as thyroid hormones, serum carnitine, acylcarnitine, selenium, urine and blood amino acids, and urine organic acid profile, was normal. Genetic, viral, and congenital etiological factors of cardiomyopathy were excluded.

Fig. 1 X-ray radiography of the left wrist.

From his history, the boy did not receive daily 25-hydroxyvitamin D (400 unit/day) prophylaxis. Maternal 25-hydroxyvitamin D levels ($< 5 \mu\text{g/mL}$) revealed severe deficiency. The diagnosis of DC, nutritional vitamin D–deficient rickets, and primary hypomagnesemia was considered. Forty drops per day orally (5,000 units) of 25-hydroxyvitamin D, 25 mg/kg/day of intravenous magnesium (quarter dose), and 50 mEq/kg of intravenous calcium replacement therapy were administered. During these replacement therapies, we did not observe any complications. Calcium and magnesium levels were normalized following the fifth day of replacement therapy. In addition to replacement of calcium, vitamin D, and magnesium, supportive treatment for DC, including positive inotropic agents (dobutamine, $7.5 \mu\text{g/kg/min}$), digitalis, diuretic, and angiotensin-converting enzyme inhibitor were administered. His rickets and hypomagnesemia responded to the replacement therapy. He was extubated on

Table 1 Laboratory parameters before and after treatment

		Before treatment	After treatment
Ionized calcium	(8.8–10.8 mEq/L)	0.84	1.2
Ca	(8.5–11.0 mg/dL)	5.13	10.75
Phosphorus	(3.5–6.6 mg/dL)	7.35	5.54
Magnesium	(1.8–2.6 mg/dL)	1.25	2.5
25 OH-Vitamin D	(20.0–120.0 $\mu\text{g/mL}$)	<5.0	45.0
ALP	(82.0–383.0 U/L)	542.0	237.0
PTH	(12.0–88.0 pg/mL)	377.6	40.0
BNP	(0.0–100.0 pg/mL)	2,610.0	10.9

Abbreviations: 25 OH-vitamin D, 25 hydroxyvitamin D; ALP, alkaline phosphatase; BNP, brain natriuretic peptide; Ca, calcium; PTH, parathormone.

the third day of hospitalization. After the 10th day of hospitalization, his EF was 66% and his electrolytes were within the normal limits. He was discharged from the hospital with 40 drops per day orally (5,000 units) of 25-hydroxyvitamin D and oral magnesium diasporal (25 mg/kg/day). After the first week, his magnesium was stopped and he was to continue 3 drops per day (400 units) of 25-hydroxyvitamin D until 1 year of age. The PTH and vitamin D levels were observed within the normal limits on the first month evaluation visit. His left ventricular systolic functions also recovered after 3 months of vitamin D supplementation.

Discussion

In children, the underlying etiology of greater than 60% of DC cases cannot be determined and therefore considered as idiopathic.³ Although, hypocalcemia secondary to nutritional vitamin D-deficient rickets is still a major worldwide health problem, hypocalcemia induced DC is rarely reported.³⁻⁵ There are a limited number of case reports, but no large scale studies have been conducted on this life threatening heart disorder that can be easily managed with the correction of the metabolic pathology.⁶

In the present case, the boy had clinical, biochemical, and radiological characteristics of vitamin D-deficient rickets associated with primary hypomagnesemia. His vitamin D-deficient rickets and hypomagnesemia responded well to replacement therapy and a satisfactory improvement was also observed in his cardiac function. His systolic EF was improved from 25 to 70% at the follow-up visit 3 months of posttherapy.

To the best of our knowledge, a combination of vitamin D-deficient rickets and primary hypomagnesemia causing DC has not been reported previously. A history of inadequate vitamin D replacement and low maternal vitamin D levels with clinical and laboratory findings of vitamin D deficiency suggested vitamin D-deficient rickets. Although it is not known whether there is a correlation between vitamin D levels and severity of clinical findings, in this case, a marked discrepancy was observed between the severity of clinical findings and the vitamin D levels. His vitamin D level (11 µg/L) was above the level accepted as severe deficiency (5 µg/L).^{7,8} This discrepancy could be explained by a contribution of primary hypomagnesemia that would inhibit secretion of PTH and prevent secondary hyperparathyroidism as the compensatory mechanism in the early stage of vitamin D-deficient rickets.

In addition, the duration that a patient remains hypocalcemic may be more predictive in the development of DC rather than an episode of severe short-term hypocalcemia. In our country, infants are advised to receive 400 units per day of 25-hydroxyvitamin D until the age of 1 year.

In conclusion, countries with a high incidence of rickets, particularly vitamin D-deficient rickets and the accompanying primary hypomagnesemia should be considered in the etiologic work up of DC in childhood.

Note

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None.

Conflict of Interest

None.

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