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Case Report

Vitamin D deficiency - a hidden culprit in dilated cardiomyopathy in children: a rare case report and review

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ABSTRACT

Vitamin D deficiency (VDD) is a significant public health concern in India, especially in infants and children. Hypocalcemia originating from VDD is a cause of dilated cardiomyopathy (DCM). Here, we reported a case of a 4-month-old infant who was diagnosed with DCM secondary to hypocalcemia-associated VDD. A 4-month-old full-term female infant presented to the emergency with three episodes of apneic spells and a feeding history of improperly prepared formula and diluted cow's milk with no other supplementation. The baby had normal vitals and no abnormal examination findings. Investigations revealed severe hypocalcemia with prolonged QTc interval on electrocardiogram. Further investigations showed VDD, and echocardiography showed DCM with mild left ventricular dysfunction. The infant was managed with calcium and mega doses of vitamin D. There was DCM resolution and ventricular function improvement. The infant was discharged with no morbiditiesn. Despite its importance, VDD persists as a significant public health challenge in Indian infants and children, resulting from a complex interplay of factors. Hypocalcemia due to VDD results in a form of reversible DCM, causing heart failure. Consistent with our case, numerous published case series have demonstrated that infants and children with VDD often present with cardiac dysfunction and DCM at various stages and show dramatic improvement following vitamin D supplementation. Dilated cardiomyopathy may be more common than previously thought as a complication of vitamin D deficiency, but early detection and timely intervention can lead to swift recovery.

Keywords: Vitamin D deficiency, Dilated cardiomyopathy, Hypocalcemia

INTRODUCTION

Vitamin D is an essential nutrient that plays a major role in maintaining calcium and phosphorous homeostasis through its actions on the kidney, intestine, and bone. Additionally, it has numerous extra skeletal effects, such as modulating cell proliferation, immune and muscle function, and vascular and metabolic properties.[1] Vitamin D deficiency (VDD) is a significant public health concern in India, especially in infants and children. In different regions of India, numerous studies have found that VDD is widespread with an estimated prevalence ranging from 60% to 80% in infants to children and children.[2,3] VDD usually causes rickets in growing children and is associated with hypocalcemia. During periods of rapid growth, such as infancy and adolescence, VDD-associated hypocalcemia may also present with seizures or tetany or apneic spells. Recent evidence has also established hypocalcemia originating from VDD as a recognized etiological cause of dilated cardiomyopathy (DCM). Contrary to the previous assumptions of rarity, emerging evidence from recent reports indicated a growing occurrence of this phenomenon in infants and children.[4-7] Unlike DCM resulting from other etiologies such as viral, genetic, or metabolic, VDD-associated DCM demonstrates a good response to medical therapy, comprising of calcium and vitamin-D supplementation. Therefore, it is essential to identify it early in its course, as

timely intervention can influence disease progression leading to improved cardiac function and patient outcomes.[8,9] Here, we report a case of a 4-month-old infant who presented with apneic spells and was diagnosed to have DCM secondary to hypocalcemia-associated severe VDD.

CASE REPORT

Clinical description

A 4-month-old female infant who was full term, spontaneous vaginal delivery with a birth weight of 3.500 kilograms (kg); at the 50th centile, was discharged home on the third day of life with no medical problems prior. The infant presented to the emergency with three episodes of apneic spells and a feeding history of improperly prepared formula and diluted cow's milk and with no other supplementation. On examination, she had no dysmorphic features, normal vital parameters, and no obvious signs of nutritional deficiencies. The baby weighed 4.800 kg; at the 50th centile, had a length of 57 centimeters (cm); at the 90th centile, and a head circumference of 39 cm; at the 50th centile. The baby also developed one episode of apneic spell in the hospital, requiring bag and mask ventilation. The initial investigations included complete blood counts, electrolytes, sugars, chest X-ray, and electrocardiogram (ECG). The investigations revealed severe hypocalcemia (serum calcium=5.5 mg/dl, ionic calcium=0.6 mMol/l), and the ECG showed a prolonged QTc interval. Further investigations identified severe VDD (4.2 ng/ml). The infant was diagnosed to have hypocalcemia secondary to VDD.

Management and outcome

Intravenous calcium correction was immediately started for the child. A pediatric cardiologist performed an echocardiogram that revealed dilated cardiomyopathy. Although the echocardiogram showed DCM with mild left ventricular dysfunction with ejection fraction (EF), the infant was not in heart failure. The infant was started on mega doses of vitamin D (30000 IU/day, every alternate day, a total of 3 doses). Following intravenous calcium correction, subsequent serum and ionic calcium level tests showed normal results, and the infant experienced no additional episodes of apneic spells. ECG also had normalized. The infant was continued on a maintenance dose of oral calcium supplements (150 mg/kg/day) and vitamin D (400 IU/day daily and 30000 IU/dose every second week for 6 weeks). An echocardiogram was repeated on the 5th day of admission, which showed the resolution of DCM and normal biventricular function with EF of 65%. The infant was discharged in stable condition, without any additional complications, and was instructed to receive properly mixed formula feeds, as the mother was unable to breastfeed and was cautioned against using any other milk sources. Additionally, calcium and vitamin D supplements were continued as part of the infant's ongoing care.

DISCUSSION

We reported a case of a 4-month-old infant with suboptimal feeding practices who presented with apneic spells due to hypocalcemia associated with VDD. Further examination revealed that the infant had cardiac dysfunction and dilated cardiomyopathy, but no heart failure. The infant was promptly managed with calcium correction and high-dose vitamin D supplements and made a rapid recovery. The infant was subsequently discharged without any adverse effects.

Calcium is an integral ion in the regulation of myocardial contraction, facilitating the coupling of electrical stimulation to mechanical response. Intracellular calcium concentration changes are vital for cardiac myocyte activity. During the cardiac action potential, calcium ions enter the cell through specialized channels, triggering the release of additional calcium from the sarcoplasmic reticulum. This influx of calcium ions binds to myofilament proteins like troponin C, initiating the contraction of the myocardium. During diastole, the decrease in intracellular calcium causes it to release from troponin C, stopping contraction and allowing the cardiac myocyte to relax. The crucial role of calcium in both the contraction and relaxation phases of the cardiac myocyte is clear. Consequently, hypocalcemia can lead to significant cardiac myocyte dysfunction. Hypocalcemia also results in a form of reversible dilated cardiomyopathy causing heart failure with reduced ejection fraction. The relationship between hypocalcemia and cardiomyopathy is complex and some of the mechanisms are yet to be understood.[10,11]

Despite its importance, VDD persists as a significant public health challenge in Indian infants and children, resulting from a complex interplay of factors. These include the effects of urbanization and shifting lifestyles, inadequate vitamin D in breast milk, insufficient supplementation, increased skin pigmentation reducing sunlight-induced vitamin D production, socioeconomic barriers, and genetic predispositions that affect vitamin D metabolism.[12] The Indian Academy of Pediatrics (IAP) strongly recommends vitamin D supplementation in doses of 400 IU/day in infants and up to 600 IU/day in older children and adolescents.[13] Notably, our patient did not receive vitamin D supplements during the infancy period, which is a critical time for bone development and immune system maturation, despite the increasing awareness and recommendations for vitamin D supplementation in this age group. This case underscores the importance of healthcare providers advising and monitoring vitamin D supplementation and easily preventing VDD-associated disorders.

At the time of presentation, our infant was diagnosed with VDD and, despite not exhibiting symptoms of heart failure, echocardiography revealed cardiac dysfunction and DCM. Fortunately, immediate administration of mega doses of vitamin D supplementation yielded a dramatic

improvement in cardiac function, as evidenced by a significant increase in ejection fraction, and a complete reversal of DCM, highlighting the critical importance of timely and appropriate treatment. Consistent with our case, numerous published case series have demonstrated that infants and children with VDD often present with cardiac dysfunction and DCM at various stages. Notably, these studies uniformly report significant improvements in cardiac function following vitamin D supplementation, characterized by rapid recovery and a low incidence of adverse events.[4,5,7,14,15] The preventability of DCM caused by VDD makes any resulting morbidity and mortality entirely unacceptable. Given the relatively low cost of supplementation, the high expense of pediatric intensive care, and the incalculable value of a child's life, it is imperative that we prioritize prevention.

CONCLUSION

Dilated cardiomyopathy may be more common than previously thought as a complication of vitamin D deficiency, but early detection and timely intervention can lead to swift recovery. Since VDD is an easily preventable cause of cardiac failure, it is crucial to increase public awareness and advocate for policy reforms in public health to address this issue comprehensively and prevent unnecessary complications.

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