

**Neonatal rickets, due to maternal vitamin D deficiency,
complicated by convulsion and dilated cardiomyopathy:
Case report**

Abstract

Deficiency rickets due to maternal hypovitaminosis D cause hypocalcaemia in infants, which may be complicated by dilated cardiomyopathy (DCM) with myocardial dysfunction. Calcium is central in myocardial contraction coupling, and hypocalcemia decreases myocardial contractility. However, dilated cardiomyopathy (DCM) due to hypocalcemia in infants has been rarely reported. Correction of hypocalcemia was associated with resolution of congestive heart failure and the left ventricular (LV) geometry and systolic function.

We report the case of an infant who presented deficiency rickets due to maternal hypovitaminosis D, complicated by convulsion and dilated cardiomyopathy, with good improvement under treatment with calcium and vitamin D.

Keywords: Rickets; hypovitaminosis D; hypocalcemia; dilated cardiomyopathy; DCM

Introduction

Rickets is a potentially serious or even fatal systemic disease, with, particularly in severe forms, neurological (convulsions, coma) and cardiac (dilated cardiomyopathy and myopathy) damage [1]. Lack of vitamin D greatly reduces the absorption of calcium and phosphorus at the digestive level. The causes of severe and early forms of rickets are multifactorial, often stemming from maternal factors, from calcium and/or vitamin D deficiency. The development and mineralization of the fetal skeleton require large and constant supplies of calcium and phosphorus during the 3rd trimester of pregnancy. Vitamin D has no direct role in placental calcium transport, but is necessary to maintain maternal calcium stores. At birth, an infant's 25(OH)D level is proportional to that of its mother [1]. In the absence of adequate vitamin D supplementation, a neonate born to a deficient mother has a lowered 25(OH)D value. It is vulnerable to an insufficient intake of calcium favored, in particular, by exclusive

breastfeeding. Deficiency rickets due to maternal hypovitaminosis D causes hypocalcemia in infants, which may be complicated by dilated cardiomyopathy (DCM) with reversible myocardial dysfunction after oral treatment with oral treatment calcium and vitamin D [3, 4]. We report the case of an infant who presented deficiency rickets due to maternal hypovitaminosis D, complicated by convulsion and dilated cardiomyopathy, with good improvement under treatment with calcium and vitamin D.

Case report

The patient is a 4-month-old infant from consanguineous parents, the third of three siblings. He was born vaginally, with good adaptation to extrauterine life, birth weight of 3300 g, exclusively breastfed, good psychomotor development, and current vaccination according to the national immunization program. Since birth, the patient presented fatigue during feedings with the notion of gaze fixity complicated by respiratory discomfort with convulsion. On admission to our department, the clinical examination found a conscious, toned and reactive infant; his weight was 6 kg, head circumference was 42 cm. Height 54 cm, temperature 37°C, and normal blood sugar. The patient is in respiratory distress with signs of heart failure. During the clinical examination, the patient had a convulsive seizure and was put in condition with an intra-rectal valium injection. After the convulsion, we assessed: the brain imaging was normal; the chest X-ray showed cardiomegaly (Figure 1) with bone demineralization. Echocardiography revealed a dilated cardiomyopathy with an ejection fraction of 30% (Figure 2), and an electrocardiogram showed repolarization disorders in V4 and V6. The complete blood count was normal. The infection profile is normal.

The dosage of electrolytes revealed hypocalcemia at $Ca^{+}=46\text{mg/l}$ with a corrected Calcium= 62 mg/l and normal phosphorus at 62 mg/l . Before this clinical and paraclinical picture. We thought of rickets by a deficit in Vit D, the corrected calciuria decreased, and the 25 OH Vit Dest decreased by seven ng/ml, parathormone increased by 120 pg. Increased alkaline phosphatase of 821 U/l. The wrist x-ray showed bony signs of rickets (Figure 3). The vitamin D dosage in the mother is less than eight ng/ml. The diagnosis of deficiency rickets secondary to maternal vitamin D hypovitaminosis was retained. The patient was treated with calcitherapy in combination with the treatment of heart failure. Once the serum calcium normalized, the patient was put on vitamin D3. The evolution was favourable, and marked by the improvement of the size of the heart chambers, the normalization of the left

ventricular ejection fraction (Figure 4), and the improvement of the radiological signs (Figure 5). The control PAL dosage showed 256 ui/l.

Discussion

Chez les nouveau-nés et les jeunes enfants, la grave carence en vitD peut nuire à la minéralisation des tissus osseux (ostéomalacie) et à la formation des plaques de croissance (rachitisme); elle peut aussi être responsable de convulsions, de myocardopathie et de manifestations plus discrètes,[2]

Maternal vitamin D deficiency during pregnancy can cause infantile rickets. Prevention involves providing vitamin D during pregnancy and breastfeeding. Vitamin D has been experiencing a spectacular resurgence of interest for some time due to its "classic" bone effects but also extra-osseous [5, 6]. 80–90% of vitamin D comes from skin biosynthesis under the effect of ultraviolet radiation. Only 10–20% of vitamin D comes from an exogenous source via the absorption of vitamin D-rich foods. Exogenous intake depends on the type of diet but also on regional habits [7]. Until recently, the minimum satisfactory concentration of vitamin D was defined as that which would prevent the onset of deficiency rickets in children and osteomalacia in adults, i.e., approximately 8 ng/ml (20 nmol/l) [8]. In 2010, most international experts agreed to set the limit values for adults. A level between 20 and 30 ng/ml (50 and 75 nmol/ml) is considered an "insufficiency"; a level between 10 and 20 ng/ml (25 and 50 nmol/l) a "deficiency"; and less than or equal to 10 ng/ml (\leq 25 nmol/ml) in vitamin D as the "deficiency" threshold below which the risk of short-term bone pathological consequences is significant. For children, there is no consensus, and it is considered that a minimum serum concentration of 20 ng/ml is necessary [9]. In the newborn, the vitamin status depends entirely on the mother's. Maternal vitamin D stores can sustain infant requirements for the first 6 weeks of life only if maternal vitamin D status is sufficient at the end of pregnancy, which is often not the case. A vitamin D deficiency has been well demonstrated in pregnant women at the end of their pregnancy. Studies have shown a relationship between this poor vitamin D status and the frequency of late or even early neonatal hypocalcemia accidents [10, 11]. In a 2001 study, Bassir et al. found in a population of Iranian pregnant women very low or zero circulating levels of plasma 25(OH)D in 80% of the population studied (57 women). Newborns had low or undetectable levels with biological signs of osteomalacia (raised circulating PTH and alkaline phosphatase), as is the

case of our patient. Moreover, the neonatal adaptation of calcium metabolism is disturbed with severe and lasting neonatal hypocalcemia [12].

Hypocalcemia caused by vitamin D deficiency leads to extra-osseous complications, particularly dilated cardiomyopathy and congestive heart failure. Calcium directly affects the myocardium's force of contraction by excitation-contraction coupling. Hypocalcemia reduces myocardial contractility, but the incidence of congestive heart failure and cardiomyopathy due to hypocalcemia is very rare [13]. Hypocalcemic cardiomyopathy is generally refractory to conventional treatments for heart failure but responds favorably to restoration of normocalcemia. Our patient's case had severe hypocalcemia due to vitamin D deficiency and responded dramatically to calcium and vitamin D correction. Maiya, et al. reported 16 cases of cardiomyopathy due to hypocalcemia in children associated with vitamin D deficiency [14]. Another study found four exclusively breastfed African American infants with congestive heart failure and dilated cardiomyopathy due to hypocalcemia, whose heart function returned to normal within months of treatment with vitamin D and calcium [15]. An Indian study found hypocalcemia in 16% of infants with severe left ventricular dysfunction; vitamin D deficiency was identified as the main cause of hypocalcemia. These children improved after vitamin D and calcium supplementation [16].

Vitamin D deficiency in developing countries is primarily nutritional, particularly in exclusively breastfed infants whose mothers have low vitamin D stores [17].

Due to the link between maternal and infant Vit D levels, prevention of maternal vit D deficiency is an important strategy to reduce symptomatic vit D deficiency in the infant, including congenital rickets in neonates. In pregnant women, the recommended dietary intake of vitamin D is 600 IU/day.

Conclusion:

Maternal CvitD can cause congenital rickets, defined as a disease that manifests within the first 30 days of life [2]. Neonatal and maternal hypovitaminosis D should be considered in the event of neonatal hypocalcemia. Systematic supplementation should be implemented in the third trimester of pregnancy to maintain adequate maternal vitamin and optimal fetal status.

Ethical Approval:

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

Consent

As per international standard, parental written consent has been collected and preserved by the author(s).

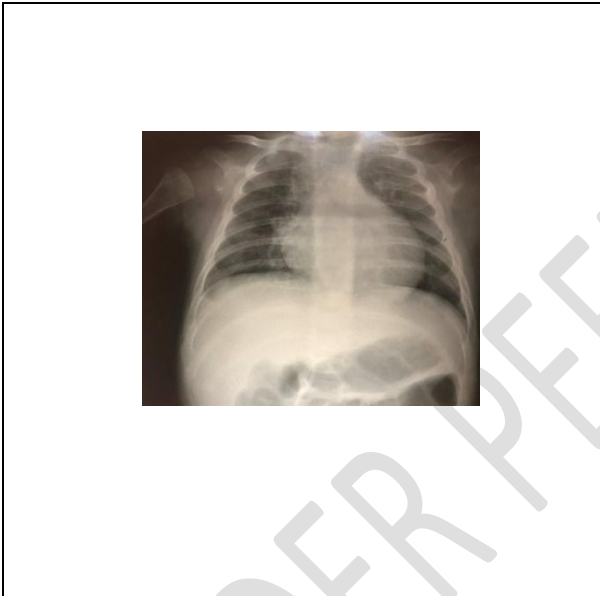


Figure 1: Chest X-ray



Figure 2: Echocardiography before treatment



Figure 3 : Radiography before treatment

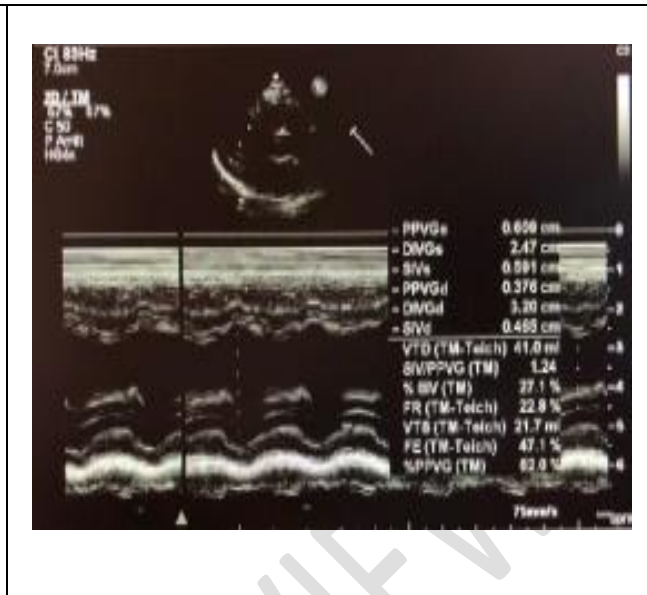


Figure 4 : Echocardiography after treatment



Figure 5 : Radiography after treatment

References :

- 1 Edouard, T., A. Linglart, and J. P. Salles. "Vitamine D et rachitisme: débats, consensus et utilisation pratique." *Perfectionnement en Pédiatrie* 1.1 (2018): 40-47.
- 2 Irvine, James, and Leanne M. Ward. "La prévention de la carence en vitamine D symptomatique et du rachitisme chez les nourrissons et les enfants autochtones du Canada." *Paediatrics & Child Health* 27.2 (2022): 128-128.
- 3 Levine SN, Rheams CN. Hypocalcemic heart failure. *Am J Med.* 1985; 78:1033–5. [PubMed] [Google Scholar]
- 4 Gurtoo A, Goswami R, Singh B, Rehan S, Meena HS. ypocalcemia-induced reversible hemodynamic dysfunction. *Int J Cardiol* 1994;43:91-3.
- 5 Audran M, Briot K. Analyse critique du déficit en vitamine D. *Revue du rhumatisme* 2010 ; 77 : 139–143.

- 6 Bacchetta J, Ranchin B, Dubourg L, Cochat Pl. Vitamine D : un acteur majeur en
santé ? Arch Pédiatr 2010;17:1687-1695.
- 7 Amstutz V, Cornuz J, Krieg M-A, Favrat B. Vitamine D : actualité et
recommandations. Revue Médicale Suisse
- 8 . St Arnaud R, Demay MB. Vitamin D biology. In: Glorieux FH, editor. Pediatric
bone, biology and diseases. London: Elsevier Science; 2003. p. 193–215.
- 9 Adams JS, Hewison M. Update in vitamin D. J Clin Endocrinol Metab 2010;95:471–
8.
- 10 Oki J, Takedatsu M, Itoh J et al. Hypocalcémie focal seizures in a one-month-old
infant of a mother with a low circulating level of vitamin D. Brain & Dev
1991;13:132- 4
- 11 Oki J, Takedatsu M, Itoh J et al. Hypocalcémie focal seizures in a one-month-old
infant of a mother with a low circulating level of vitamin D. Brain & Dev
1991;13:132- 4
- 12 Bassir M, Laborie S, Lapillonne A et al. Vitamin D deficiency in Iranian mothers and
their neonates: A pilot study. Acta Paediatr 2001; 90: 567- 570
<https://doi.org/10.1016/j.revmed.2015.03.205>
- 13 Benzarouel D, Hasni K, Ashab H, El Hattou M. Une cause réversible de la
cardiomyopathie dilatée : l'hypocalcémie. Ann Cardiol Angeiol 2014;63:102–6
- 14 Douban S, Brodsky MA, Whang DD, Whang R. Significance of magnesium in
congestive heart failure. Am Heart J 1996;132:664–71.
- 15 TOMAR, Munesh, RADHAKRISHNAN, Sitaraman, et SHRIVASTAVA, Savitri.
Myocardial dysfunction due to hypocalcemia. Indian pediatrics, 2010, vol. 47, no 9,
p. 781-783.
- 17 Dawodu, A., and C. L. Wagner. "Prevention of vitamin D deficiency in mothers and
infants worldwide—a paradigm shift." Paediatrics and international child
health 32.1 (2012): 3-13.