The Role of Oral Calcium and Vitamin D in Hypocalcemia-Associated Cardiomyopathy: A Case Report

Meity Ardiana[a], Bambang Herwanto[a], Inna Maya Sufiyah[a], Wynne Widiarti[b], Alviannur Halim[a]

[a] *Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Surabaya, Indonesia*
[b] *Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia*

ARTICLE INFO

Article history:
Submitted: 10. 7. 2024
Accepted: 21. 7. 2024
Available online: 25. 11. 2024

Klíčová slova:
Dilatační kardiomyopatie
Hypoparatyreóza
Kalcium
Srdeční selhání

SOUHRN

Hypokalcemií indukovaná kardiomyopatie je vzácné, avšak závažné onemocnění, náročné z hlediska diagnostiky i léčby. Těžká hypokalcemie na podkladě hypoparatyreózy může vyvolat vzácnou, nicméně potenciálně reverzibilní, formu dilatační kardiomyopatie. Tato kazuistika popisuje případ 31leté ženy se srdečním selháním vyvolaným hypoparatyreózou po tyreoidektomii. Přes klasickou léčbu srdečního selhání přetrvával u pacientky její závažný stav až do úpravy hypokalcemie. Léčba zahrnovala suplementaci kalcia a terapii vedenou podle příslušných doporučených postupů; následně došlo k významnému zlepšení. Proto je pro dosažení zlepšení – pokud byla klasická léčba srdečního selhání neúčinná – naprosto nezbytné monitorovat hodnoty kalcia v séru, zvláště u pacientů s tyreoidektomií v anamnéze. Při léčbě srdečního selhání je třeba být ostražitý a mít neustále na paměti možnou přítomnost hypokalcemie jako reverzibilní příčinu uvedené komplikace.

Keywords:
Calcium
Dilated cardiomyopathy
Heart failure
Hypoparathyroidism

ABSTRACT

Hypocalcemia-associated cardiomyopathy, a rare but serious condition, presents challenges in diagnosis and management. Severe hypocalcemia resulting from hypoparathyroidism can precipitate rare yet reversible cases of dilated cardiomyopathy. This case report reported a 31-year-old woman with heart failure precipitated by hypoparathyroidism following thyroidectomy. Despite conventional heart failure treatments, her condition persisted until correction of hypocalcemia. Treatment involved calcium supplementation and guideline-directed heart failure therapy. Significant improvement was observed then. Hence, monitoring serum calcium levels is imperative when conventional heart failure therapies fail to yield improvement, particularly in patients with a history of thyroidectomy. Sustaining clinical awareness and vigilance concerning hypocalcemia is crucial in managing heart failure, considering its possibility as a reversible cause.

Introduction

Calcium plays a pivotal role in both systolic contraction and diastolic relaxation of myocardium. Upon depolarization, calcium influx via voltage-sensitive L-type calcium channels initiates myocardial contraction, complemented by calcium release from the sarcoplasmic reticulum. This cascade of events involves calcium binding to specific proteins, facilitating contraction, and subsequent relaxation occurs as calcium is reabsorbed into storage sites.[1] Hypocalcemia, characterized with low levels of circulating calcium, profoundly disrupts myocardial contraction, potentially leading to ventricular dysfunction and subsequent heart failure. Although hypocalcemia contributes to cardiomyopathy, additional mechanisms underlying this condition remain to be fully elucidated. Recent research underscores the similar impact of vitamin D and parathy-

Address: Meity Ardiana, MD, FIHA, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Surabaya, Indonesia, e-mail: meityardiana@fk.unair.ac.id
DOI: 10.33678/cor.2024.058

Please cite this article as: Ardiana M, Herwanto B, Sufiyah IM, et al. The Role of Oral Calcium and Vitamin D in Hypocalcemia-Associated Cardiomyopathy: A Case Report. Cor Vasa 2025;67:73–76.

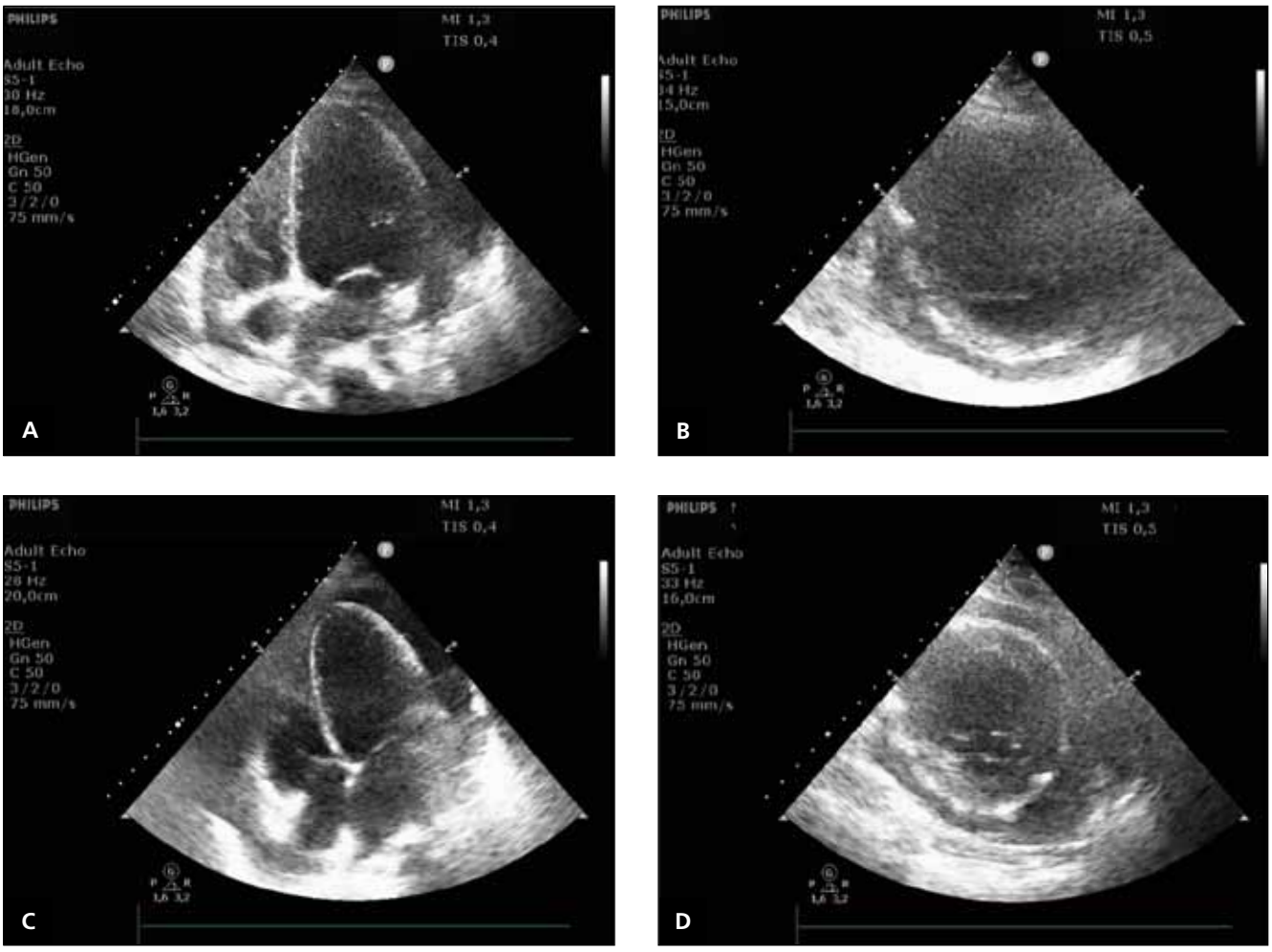

Fig. 1 – Changes in the pre-treatment (A, B) and post-treatment (C, D).

Table 1 – Evaluated laboratory parameters

Parameters	Normal range	Pre-treatment	Post-treatment (D + 4)
Creatinine (mg/dL)	0.7–1.4	1.3	N/A
Albumin (g/dL)	3.2–5.5	3.58	N/A
Calcium (mg/dL)	8.5–10.5	4.0	7.9
Magnesium (mmol/L)	0.8–1.2	1.2	1.9
TSH (mIU/L)	0.5–5.0	13.828	N/A
QT interval (mS)	360–460	662	441
Ejection fraction (%)	> 50	29.4	33.3

roid hormone (PTH) on myocardial function, suggesting broader implications beyond calcium regulation.[2]

Dilated cardiomyopathy (DCM) is a cardiac condition characterized by structural and functional abnormalities in the heart muscle, unrelated to other etiologies. Various factors can lead to DCM, including primary familial causes and secondary factors like myocarditis, toxins, autoimmune disorders, neuromuscular conditions, and endocrine issues. Among these, hypocalcemia has been identified as a reversible contributor to DCM.[3] Hypocalcemia-induced cardiomyopathy is typically characterized by a reduced ejection fraction (EF), often resistant to conventional heart failure therapy regimens. Despite resistance to conventional treatments, correcting the underlying cause of low calcium levels can rapidly improve the condition.[2,4] In this paper, we present a case report reporting heart failure precipitated by hypocalcemia, concomitant with hypoparathyroidism. By elucidating this case, we aim to advance understanding and refine management strategies for similar clinical presentations, contributing to prompt diagnosis and appropriate treatment of this case.

Case description

A 31-year-old woman presented to the emergency unit with shortness of breath, accompanied with cramps and body aches. She had a history of thyroidectomy for hypothyroidism two years prior and cataract surgery one year ago. During the physical examination, she weighed 80 kg and measured 156 cm in height. Her blood pressure was 90/67 mmHg while on 50 µg of norepinephrine and 5 µg of dobutamine, with a heart rate of 71 beats per minute. Fine wet crackles were noted in the basal third of both lungs. The electrocardiogram examination indicated a sinus rhythm at 73 beats per minute, slow R wave progression in leads V_1–V_3, and a prolonged QT interval (QTc with Bazett formula 662 ms).[5] Laboratory tests revealed an HB level of 11.1 g/dL, creatinine at 1.3 mg/dL, albumin 3.58 g/dL, calcium at 4.0 mg/dL, magnesium 1.2 mg/dL, TSH at 13.8 mIU/L, and FT4 at 0.94.

Treatment was initiated with norepinephrine 50 µg and dobutamine 5 µg, raising her blood pressure to 105/57 mmHg. Parenteral calcium was administered to address symptoms of hypocalcemia, along with correction for hypomagnesemia. After symptom improvement, therapy was switched to oral calcium 3000 mg/day and calcitriol 0.25 mg/day, and levothyroxine 250 mg/day was prescribed for her hypothyroidism. The transthoracic echocardiogram (TTE) revealed reduced left ventricular systolic function (ejection fraction with Simpson's biplane method 29.4%), global left ventricular hypokinesis, left ventricular dilation with eccentric hypertrophy, diastolic dysfunction, and moderate pericardial effusion. Treatment included spironolactone 50 mg daily, ivabradine 10 mg/day, and intravenous furosemide. Beta-blockers and ACE inhibitors/ARNIs were postponed due to ongoing support with norepinephrine and dobutamine.

Four days later, her symptoms of dyspnea, cramps, and aches had diminished following normalization of her calcium levels, allowing cessation of norepinephrine and dobutamine. Consequently, bisoprolol 2.5 mg/day and ramipril 5 mg/day were introduced. A follow-up ECG showed a sinus rhythm and a corrected QT interval of 441 ms, while a repeat echocardiogram showed an improvement in ejection fraction to 33% and left ventricular systolic function nearing the lower normal limit.

Discussion

This case report highlights a case of reversible heart failure precipitated by hypoparathyroidism following thyroidectomy surgery. The patient exhibited rapid improvement after receiving a combination of guideline-directed medication of heart failure and calcium replacement.

Dilated cardiomyopathy (DCM) is a condition marked by the enlargement and dilation of one or both ventricles, coupled with reduced contractility, typically indicated by a left ventricular ejection fraction (LVEF) under 40%.[6] Causes of reversible DCM include alcoholism, postpartum cardiomyopathy, and hypoparathyroidism.[7] Parathyroid hormone (PTH) plays a crucial role in calcium homeostasis, influencing bone resorption by osteoclasts, enhancing intestinal calcium absorption, and activating vitamin D in the kidneys. Additionally, PTH can exert a positive inotropic effect on the heart by increasing myocardial contraction through the stimulation of B-adrenergic receptors and promoting calcium influx into myocardial cells.[8] Deficiency in PTH, primarily resulting from surgical procedures on the neck, can lead to hypocalcemia, which is the most common cause of hypoparathyroidism. Other causes include radiation therapy, autoimmune conditions, and genetic mutations.[9] Severe and prolonged hypocalcemia can impair myocardial contractions, potentially leading to ventricular systolic dysfunction and heart failure with reduced ejection fraction. Fortunately, DCM-related hypocalcemia usually has a favorable prognosis, with systolic function typically normalizing between three to twelve months.[2]

Calcium also plays a fundamental role in myocardial contraction, particularly intracellular calcium concentration. During the depolarization, activation of voltage-sensitive L-type calcium channels facilitates calcium influx into the cell, alongside contributions from exchanges like Na+–Ca2+ exchange.[10] This influx triggers calcium release from the sarcoplasmic reticulum, leading to calcium binding with cytosolic buffers, notably troponin C, activating myofilaments for contraction. Conversely, during diastole or relaxation, the decline in intracellular calcium concentration allows for calcium dissociation from troponin C, halting contraction and enabling relaxation, facilitated by various transporters.[11] This intricate process underscores the pivotal role of calcium in both systolic contraction and diastolic relaxation of myocardium, with hypocalcemia potentially precipitating severe cardiac dysfunction and heart failure. However, additional mechanisms contributing to cardiomyopathy in hypocalcemia remain unclear.[12]

In the case we present, the patient developed heart failure symptoms due to DCM triggered by chronic, untreated hypocalcemia following iatrogenic hypoparathyroidism from thyroid surgery. The combination of heart failure management and calcium supplementation led to significant improvement in the patient's heart function and symptoms. Furthermore, patients with chronic hypocalcemia may experience non-specific symptoms such as fatigue, muscle weakness, and cramps, complicating the diagnosis in the absence of tetany. Notably, the presence of cataracts, especially in younger patients, can also indicate hypoparathyroidism, underscoring the need for increased vigilance among ophthalmologists for earlier diagnosis.[13,14] While acute coronary syndrome can manifest similarly to heart failure with reduced EF, distinguishing between the two is crucial. Typically, the diagnosis is supported by changes in cardiac biomarkers.[15] However, in our case, the improvement in left ventricular EF following calcium therapy confirmed that the heart failure was due to hypocalcemia rather than myocardial infarction. Hence, calcium levels should always be monitored in HF patients and the underlying causes of low calcium levels should be investigated. Beyond the guideline-directed medication of heart failure, it is crucial to include calcium supplementation in the treatment regimen of these patients.

Conclusions

Severe hypocalcemia resulting from hypoparathyroidism can trigger an uncommon yet potentially reversible case of dilated cardiomyopathy. This case report reported a 31-year-old woman with heart failure precipitated by hypoparathyroidism following thyroidectomy. Despite conventional heart failure treatments, her condition persisted until correction of hypocalcemia. Treatment involved calcium supplementation and guideline-directed heart failure therapy. Significant improvement was then observed. Hence, monitoring serum calcium levels is imperative when conventional heart failure therapies fail to yield improvement, particularly in patients with a history of thyroidectomy. Sustaining clinical awareness and vigilance concerning hypocalcemia is crucial in managing heart failure, considering its possibility as a reversible cause.

Conflict of interest

The authors declare no competing interests.

Funding

We disclose any potential conflicts of interest, financial or otherwise, that might be perceived as influencing the content of this study.

Ethical statement and informed consent

We declare that the case report has been conducted in accordance with applied ethical standards and guidelines; the Declaration of Helsinki. Appropriate permissions including written informed consent were obtained.

Availability of data and material

We agree to make the relevant data and materials of the case report available to the journal and readers, upon reasonable request, to ensure transparency and reproducibility.

Authors' contributions

We confirmed that we have contributed significantly to this study. All listed authors have reviewed and approved the final version of the manuscript, also agreed to the submission.

Acknowledgements

We would like to express our sincere gratitude to the staff of the Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Airlangga – Dr. Soetomo General Academic Hospital, Surabaya, East Java, Indonesia.

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