CorSalud. 2023 Jul-Sep;15(3):xxx-xxx

CorSalud

Cuban Society of Cardiology

Case Report

Cardiocentro Ernesto Che Guevara Santa Clara Cuba

Hyperthyroidism and heart failure

Andrew S. Dzebu, MD; Mariam González Gorrín, MD; and Alain Gutiérrez López, MD

Cardiology Department, *Hospital Hermanos Ameijeiras*. Havana, Cuba.

Full English text of this article is also available

ARTICLE INFORMATION

Received: January 21, 2023
Accepted: March 18, 2023
Online: March 30, 2023

Competing interests
The authors declare no competing interests.

Figures
Written informed consent was obtained from the patient for the publication of this Case Report and any accompanying images.

Acronym
HR: heart rate

Andrew Sefenu Dzebu
Cardiology Department
Hospital Hermanos Ameijeiras
San Lázaro Nº 706, entre Belascoaín y Marqués González.
Centro Habana 10300.
La Habana, Cuba.
E-mail address:
asdzebu@icloud.com

ABSTRACT
Heart failure is a public health problem. Atrial fibrillation is the most frequently associated clinical arrhythmia. The concomitant presentation of both entities portends a worse prognosis. The etiology of cardiac dysfunction is imperative to determine treatment. Amongst these are thyroid diseases. About 6% of patients with hyperthyroidism present with heart failure as the only clinical problem. We present a patient with heart failure and atrial fibrillation, where the etiology was determined to be hyperthyroidism. The patient presented no additional symptoms or signs of hyperthyroidism (subclinical hyperthyroidism; <3% of cases). Optimal medical therapy was administered including ablation of the thyroid gland with radioactive iodine, and successful synchronized electrical cardioversion. The clinical progress was excellent once the euthyroid state was achieved and she remained in sinus rhythm.
Keywords: Heart failure, Atrial fibrillation, Treatment

Hipertiroidismo e insuficiencia cardíaca

RESUMEN
La insuficiencia cardíaca es un problema de salud pública. La fibrilación auricular es la arritmia clínica que más comúnmente se asocia a ella. La presencia concomitante de ambas enfermedades empeora el pronóstico. La causa de la disfunción cardíaca subyacente es fundamental para el tratamiento, dentro de ella se encuentran las enfermedades del tiroides. Un 6% de los pacientes con hipertiroidismo presenta clínicamente insuficiencia cardíaca como única manifestación. En este artículo se presenta una paciente con insuficiencia cardíaca y fibrilación auricular en quien se demostró que la causa era el hipertiroidismo. La paciente no presentó otros síntomas o signos clínicos de su enfermedad tiroidea (hipertiroidismo subclínico; <3% de los casos). Se inició tratamiento médico óptimo, así como ablación de la glándula tiroidea con yodo radioactivo; además, se realizó una cardioversión eléctrica sincronizada que resultó efectiva. Tras alcanzar el estado eutiroideo, la paciente tuvo muy buena evolución clínica y se mantuvo en ritmo sinusal.
Palabras clave: *Insuficiencia cardíaca, Fibrilación auricular, Tratamiento*

INTRODUCTION

Heart failure is a global public health problem, and Cuba is no exception. Its etiology is varied and includes coronary disease, arterial hypertension, valvular heart disease, cardiomyopathy (hypertrophic, restrictive, and dilated), and cardiac arrhythmias (heritable and acquired). There are also triggering factors, such as situations of high cardiac output, including anemia, pregnancy, and thyrotoxicosis.

However, it is not common in daily clinical practice for metabolic disorders, such as thyroid dysfunction per se, to lead to heart failure since their diagnosis, based on florid clinical manifestations and

complementary tests, is usually made early, which allows for the timely initiation of appropriate treatment. Nevertheless, a group of patients may have subclinical forms of thyroid disorders, which makes their recognition a little more difficult and, in turn, produces or perpetuates diseases such as atrial fibrillation, which, over time, can cause heart failure, cerebrovascular disease, and death[1-3].

This paper presents the case of a patient with clinical symptoms of heart failure and atrial fibrillation with rapid ventricular response, in which heart rate (HR) control was not achieved, even with high doses of negative chronotropic medications. This required a search for a predisposing cause. The diagnosis of subclinical hyperthyroidism was demonstrated, and, therefore, optimal medical therapy was started. The thyroid gland was ablated with radioactive iodine, and the synchronized electrical cardioversion was performed, which restored sinus rhythm. The clinical evolution was favorable: once the euthyroid state was achieved, the clinical manifestations of heart failure subsided, and the patient remained in sinus rhythm.

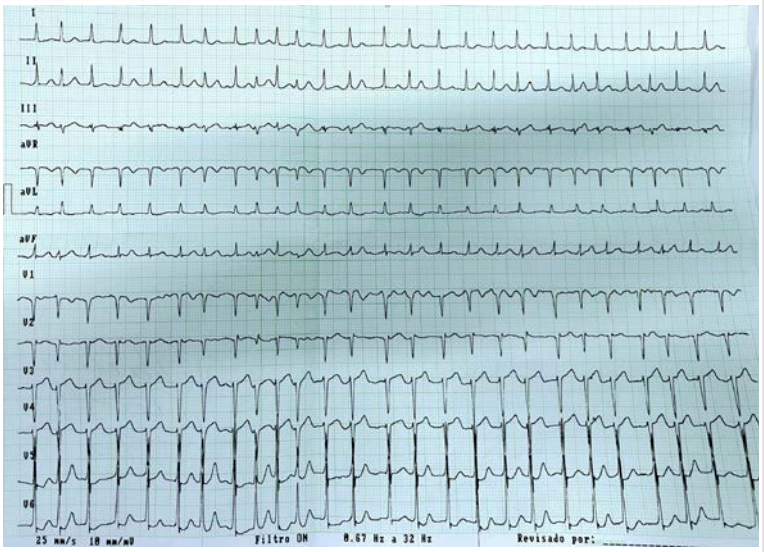

Figure 1. 12-lead electrocardiogram performed during admission. Irregular narrow QRS complex tachycardia with the absence of P waves.

CASE REPORT

A 55-year-old woman with a history of type I diabetes mellitus was diagnosed 4 years ago (onset was with diabetic ketoacidosis) and treated with long-acting insulin (14 IU at night) and crystalline insulin (10 IU after the main meals of the day). She reports having been asymptomatic until two days before admission, when she began to notice palpitations, without angina, dyspnea, or cough, accompanied by swelling of the lower limbs. She went to the outpatient clinic, where she was diagnosed with tachycardia of 150 beats per minute (bpm), with irregular heart sounds and a variable first sound.

The electrocardiogram showed the described FC and the presence of QRS complexes of 100 ms, not equidistant from each other, and with the absence of P waves, pathological Q waves, and ST-T segment abnormalities, corresponding to atrial fibrillation with a rapid ventricular response (**Figure 1**). She was subsequently transferred to the Cardiology Emergency Service, and it was decided that she should be admitted to the Coronary Care Unit. Upon physical examination, she was observed to be anxious, and the presence of painless grade 1 pitting edema in both lower limbs was confirmed. In addition, jugular vein distention was noted (approximately 10 cm above the angle of Louis), *delirium cordis* on auscultation, blood pressure of 130/80 mmHg, and HR of 150 bpm, as well as decreased breath sounds in the lower third of the right hemithorax.

The electrocardiogram was repeated, and a tracing similar to the initial one was obtained. The posteroanterior chest X-ray revealed an increased cardiothoracic index, signs of pulmonary congestion, and a small homogeneous diffuse radiopacity of the right cardiophrenic and costophrenic angles, compatible with mild pleural effusion (**Figure 2**).

The resting transthoracic echocardiogram described a moderate dilatation of the left atrium (indexed volume of 38.9 ml/m^2), normal biventricular systolic function, absence of valvular or segmental contractility of the left ventricle abnormalities, with a prolonged relaxation diastolic pattern (**Figure 3**).

The initial hypothesis of congestive heart failure secondary to atrial fibrillation with rapid ventricular response was made. It was decided, as initial therapy, to control the HR with a bolus of digoxin (250 mcg intravenously), together with diuretics (40 mg of intravenous furosemide every 8 hours and 25 mg/day of spironolactone orally), 5 mg/day of enalapril orally and anticoagulation with nadroparin (0.6 ml subcutaneous every 12 hours). Despite treat-

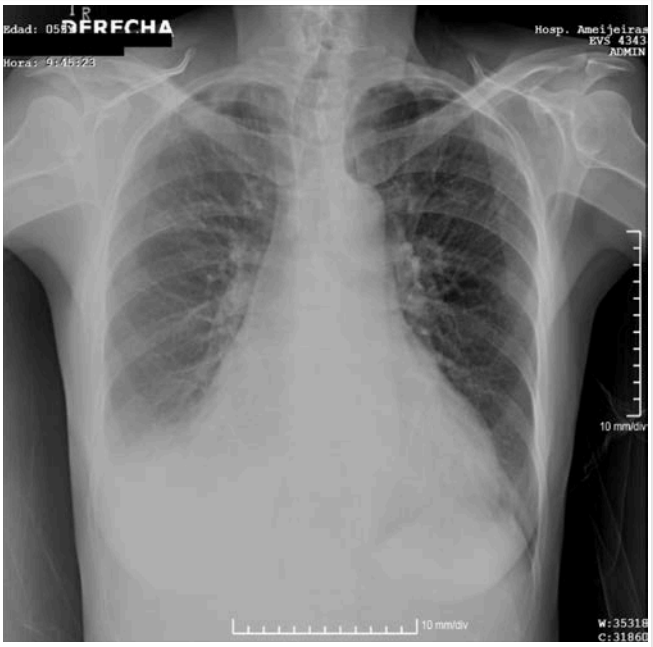

Figure 2. Posteroanterior chest X-ray. An increased cardiothoracic index (0.7), congestive hila, and a small homogeneous radiopacity is observed at the right cardiophrenic and costophrenic angles.

ment, the patient maintained a ventricular response of 120 bpm, and it was decided to add carvedilol (3.125 mg every 12 hours) without decreasing HR. A daily digoxin tablet (250 mcg) was added, and the carvedilol dose was progressively increased up to 12.5 mg every 12 hours, with the intention of achieving HR control.

Although the signs of congestion were eliminated, the patient maintained a ventricular response of around 100 bpm, so it was decided to study possible predisposing causes of the persistent tachycardia without attempting a strategy to restore sinus rhythm. Most of the complementary blood tests were within the normal range (**Table**), but the thyroid function test helped in the diagnosis of primary hyperthyroidism by revealing a decrease in TSH (thyroid-stimulating hormone: 0.1 mIU /L) and an increase in thyroxine (T4: 320 nmol /L), so treatment with radioactive iodine (I^{131}) was prescribed.

Rate control was attained, oral anticoagulation with warfarin was started, and the patient was discharged from the hospital, with follow-up at the outpatient clinic, after the successful restoration of sinus rhythm using synchronized electrical cardioversion on the second attempt once the patient was already in a euthyroid state.

In the third month of follow-up, a significant clinical improvement was observed, with increased functional capacity, disappearance of edema in the lower limbs, and persistence of sinus rhythm.

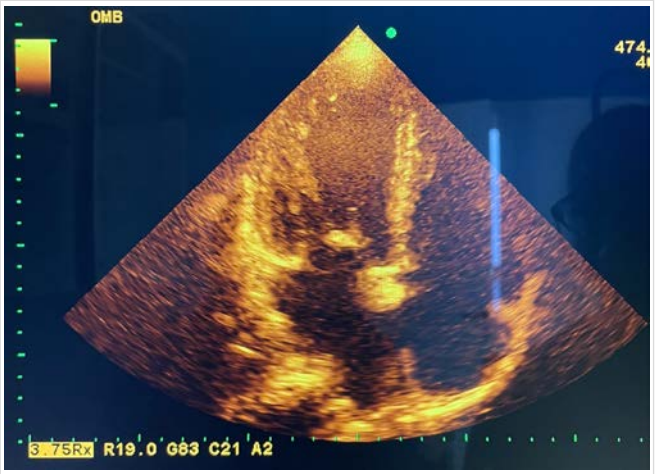

Figure 3. Echocardiogram with apical 4- chamber view.

COMMENT

Heart failure is a major cause of morbidity and mortality worldwide. Atrial fibrillation, as a cause or consequence, is a frequently associated disease, especially if it coexists with thyroid dysfunction. However, heart failure caused by hyperthyroidism is not common in daily clinical practice[1,2,4], although its impact on heart failure with increased cardiac output is recognized.

Patients with persistent thyroid gland dysfunction may present structural and functional cardiac changes. Thyroid hormones can modify cardiac performance through genomic and non-genomic effects[4-6]. Triiodothyronine (T3) is the most metabolically active at the cardiac level.

Thyroid hormones can positively or negatively stimulate the expression of several genes in cardiomyocytes. α-myosin heavy chains, the calcium ATPase ($SERCa^{2+}$) pump in the sarcoplasmic reticulum, the sodium-potassium pump (Na^+/K^+ ATPase), β1-adrenergic receptors, and voltage-gated potassium channels are some of the structures whose genes are positively regulated. Those negatively regulated include the β-myosin heavy chain, the catalytic subunits of adenyl cyclase, the sodium-calcium pump (Na^+/Ca^{2+}), the α1 thyroid hormone receptor, and phospholamban, a membrane protein with 52 amino acid complex that inhibits the calcium

Table. Summary of complementary laboratory tests performed.

Exam	Result	Reference value
Erythrocyte sedimentation rate	16	4 - 20 mm/h
Creatinine	44	47,6 - 113,4 µmol/L
Aspartate Aminotransferase	24	0 - 46 U/L
Alanine Aminotransferase	18	0 - 49 U/L
Albumin	38	38 - 54 g/L
Total proteins	58	60 - 80 g/L
Hemoglobin	12.2	120 - 160 g/L
Hematocrit	0,37	0,35 - 0,55
TSH	0,1	0,37 - 4,7 mUI/L
Thyroxine (T4)	320	60 - 150 nmol/L
Addis Count (2 hours)	Relevant. Dosable proteins: No Cast: 0	Relevant. Measurable proteins: <0.03 mg/min Casts: <250/min
VDRL	No reactivo	No reactivo
Rheumatoid Factor (IgG/ IgA/ IgM) ELISA	7	0 - 23 UI/ml

Ig, immunoglobulin; TSH, *thyroid-stimulating hormone*; VDRL, *Veneral Disease Research Laboratories*

(Ca^{2+}) pump in the sarcoplasm of cardiomyocytes, which regulates contractility and relaxation. Consequently, thyroid hormones have inotropic, chronotropic, lusitrophic, and dromotropic effects and increase adrenergic sensitivity[4-8].

Triiodothyronine (T3) produces arteriolar vasodilation, which causes a decrease in peripheral vascular resistance (PVR) through the stimulation of nitric oxide production. The decrease in PVR produces renal hypoperfusion, which activates the renin-angiotensin-aldosterone system[5,6,9]. The persistent hyperthyroid state then produces heart failure due to hypercontractility and elevated cardiac output at rest, tachycardia, supraventricular arrhythmias, systolic arterial hypertension, increased ventricular filling pressures and pulmonary pressures, and an increase in preload[3-6]. Supraventricular arrhythmias have their arrhythmogenic substrates in reentry, decreased action potential, and increased atrial ectopic activity[7].

Control of HR in patients with atrial fibrillation and hyperthyroidism can be difficult. However, it is known that most patients revert to sinus rhythm after several months of returning to a euthyroid state. Therefore, the approach to treating patients with atrial fibrillation caused by hyperthyroidism should be the cure of the thyroid disease: surgery, ablation with radioactive iodine (I^{131}), and, to a lesser extent, pharmacotherapy[5,7,9-11].

REFERENCES

1. McDonagh TA, Metra M, Adamo M, Gardner RS, Baumbach A, Böhm M, *et al.* 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42(36): 3599-3726. [DOI]
2. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, *et al.* 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/ American Heart Association Joint Committee on Clinical Practice Guidelines. Circulation. 2022; 145(18):e895-e1032. [DOI]
3. Smedegaard SB, Riis AL, Christiansen MK, Linde JKS. Subclinical hyperthyroidism and the risk of developing cardiovascular disease - A systematic review. Dan Med J [Internet]. 2020 [cited Jan 5, 2023];67(11):A12190701. Available at:

https://ugeskriftet.dk/dmj/subclinical-hyperthyroidism-and-risk-developing-cardiovascular-disease-systematic-review

4. Razvi S, Jabbar A, Pingitore A, Danzi S, Biondi B, Klein I, *et al*. Thyroid Hormones and Cardiovascular Function and Diseases. J Am Coll Cardiol. 2018;71(16):1781-96. [DOI]
5. Osuna PM, Udovcic M, Sharma MD. Hyperthyroidism and the Heart. Methodist Debakey Cardiovasc J. 2017;13(2):60-3. [DOI]
6. Grais IM, Sowers JR. Thyroid and the heart. Am J Med. 2014;127(8):691-8. [DOI]
7. Kalra S, Kishor K, Khandelwal D. Atrial fibrillation: The endocrine connection. J Pak Med Assoc [Internet]. 2019 [cited Jan 10, 2023];69(11):1746-9. Available at: https://www.archive.jpma.org.pk/article-details/9427
8. Khurana NK, Kumar S, Kumar S, Kumar P, Rizwan A. Frequency of Cardiovascular Manifestation in Patients With Hyperthyroidism. Cureus [Internet]. 2021 [cited Jan 14, 2023];13(1):e12839. Available at: https://doi.org/10.7759/cureus.12839
9. Ali R, Tahir A, Posina KV. A Case Report of Dilated Biventricular Heart Failure from Hyperthyroidism: A Rare Presentation. Cureus [Internet]. 2018 [cited Jan 14, 2023];10(4):e2410. Available at: https://doi.org/10.7759/cureus.2410
10. Sadiq AM, Chamba NG. Challenges in the Management of Thyrotoxicosis Associated with Atrial Fibrillation and Heart Failure: Two Case Reports. Clin Med Insights Case Rep [Internet]. 2021 [cited Jan 14, 2023];14:1179547621994573. Available at: https://doi.org/10.1177/1179547621994573
11. Lee JY, Lee SH, Kim WH. Reversible severe tricuspid regurgitation associated with Graves' disease: A case report. Medicine (Baltimore) [Internet]. 2021 [cited Jan 20, 2023];100(51):e28432. Available at: https://doi.org/10.1097/md.0000000000028432