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MINI-FOCUS ISSUE: IMAGING

INTERMEDIATE

CASE REPORT: CLINICAL CASE

Eosinophilic Myocarditis in a Patient With *Strongyloides stercoralis* Infection

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ABSTRACT

A 40-year-old woman with a pulmonary embolism, central nervous system infarcts, and eosinophilia was referred for evaluation. Findings on echocardiography and cardiac magnetic resonance were consistent with eosinophilic myocarditis with left ventricular involvement. Further examination led to the diagnosis of *Strongyloides stercoralis* infection, and treatment with ivermectin and rivaroxaban resulted in clinical, laboratory, and cardiac imaging improvement. (**Level of Difficulty: Intermediate.**) (J Am Coll Cardiol Case Rep 2021;3:954–9) © 2021 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 40-year-old woman with a history of seizures and thyroidectomy was referred from another hospital. Ten days after her initial admission, she reported a dry cough, shortness of breath, vomiting, diarrhea, and mild fever. She also reported facial numbness and a transient episode with visual impairment of the left eye. Laboratory investigation revealed moderate eosinophilia, echocardiography revealed increased thickness of the myocardial walls, and corticosteroid treatment was initiated. The magnetic resonance scan revealed numerous small brain infarcts bilaterally. During her initial hospitalization, her dyspnea worsened, requiring high-flow supplemental oxygen with an increase in D-dimers. At that time, an intermediate- to high-risk pulmonary embolism was confirmed with echocardiography and CT pulmonary angiography (Figure 1). Subsequently, subcutaneous low-molecular-weight heparin was given, with gradual improvement of the patient's clinical condition. When admitted to our department, she was asymptomatic, and the clinical examination was unremarkable. She had been receiving anticoagulation therapy (rivaroxaban), steroids (prednisolone), and

LEARNING OBJECTIVES

- To recognize the underlying pathophysiology in patients with pulmonary and systemic emboli and explain the clinical presentation.
- To perform CE and CMR imaging for the diagnosis and follow-up of eosinophilic myocarditis when biopsy is not applicable.
- To determine the cause of eosinophilic myocarditis, perform treatment and define prognosis.

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antihistamines (levocetirizine) for approximately 5 days.

PAST MEDICAL HISTORY

She lived in a rural area and had not traveled abroad recently. She worked as clerk in a private company, and her husband was a gardener. Her medical history included epilepsy since childhood, treated with oxycarbazepine, and thyroidectomy, after which she started taking levothyroxine.

DIFFERENTIAL DIAGNOSIS

On the basis of the patient's history and echocardiographic findings, the diagnosis of eosinophilic myocarditis was speculated, but further tissue characterization was needed. The differential diagnosis of eosinophilic myocarditis included hypereosinophilic syndrome, drug-induced eosinophilia, clonal eosinophilia, reactive eosinophilia from parasitic infection, and autoimmune disease-related eosinophilia.

INVESTIGATIONS

Eosinophil counts in the peripheral blood had decreased within normal reference numbers, but D-dimers and high-sensitivity troponin levels were increased. Color Doppler sonography of the lower extremities was consistent with deep vein thrombosis. Radiographs, abdominal sonography, and slit-lamp examination findings were unremarkable.

T-wave inversion was found in the electrocardiogram (ECG) (**Figure 2**), and the echocardiogram revealed thickened walls, with the presence of tissue with abnormal echogenicity that occupied a significant proportion of the left ventricular (LV) cavity (**Figures 3A to 3D,** Videos 1, 2, 3, and 4). LV systolic function was mildly reduced (ejection fraction 45%). There were no echocardiographic signs of restrictive cardiomyopathy, and the right ventricle was unaffected. The mitral valve appeared less affected, with mild to moderate regurgitation. Contrast-enhanced echocardiography (CE) with a very low mechanical index revealed reduced perfusion near the endocardial borders without definite evidence of thrombotic material (**Figure 4,** Video 5).

An ECG-gated cardiac magnetic resonance (CMR) study was performed, and both cine steady-state free precession and late gadolinium enhancement images were acquired in the 2-chamber, 4-chamber, and short-axis planes. Gadolinium enhancement images were obtained 5 to 20 min after intravenous gadolinium administration, by constantly adjusting inversion time to null normal myocardium; these images revealed extensive mural thrombi that were clearly differentiated from adjacent myocardium. In addition, on late gadolinium enhancement images there was almost circumferential subendocardial enhancement, involving the papillary muscles, representing inflammation and necrosis secondary to eosinophilic infiltration (**Figure 5**). Coronary artery catheterization was not performed because of the low probability of coronary artery disease, but it was suggested to the patient after the resolution of the myocarditis.

To explain the eosinophilia, stool samples were examined for parasites and worms, and serological tests were ordered. Tests for antibodies for autoimmune diseases, blood coagulation panels, and thoracic and abdominal CT scans were unremarkable. Bone marrow biopsy was also performed, and genetic mutations for clonal eosinophilia were not detected.

ABBREVIATIONS AND ACRONYMS

CE = contrast-enhanced transthoracic echocardiography

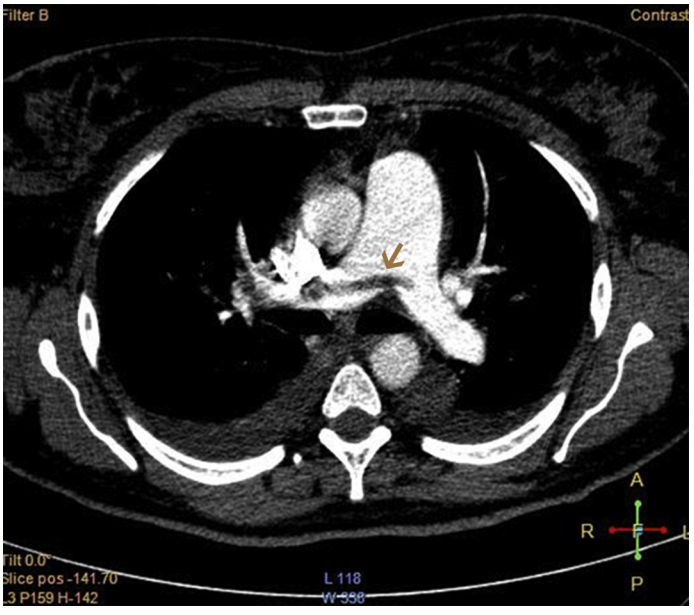
CMR = cardiac magnetic resonance

CT = computed tomography

ECG = electrocardiogram

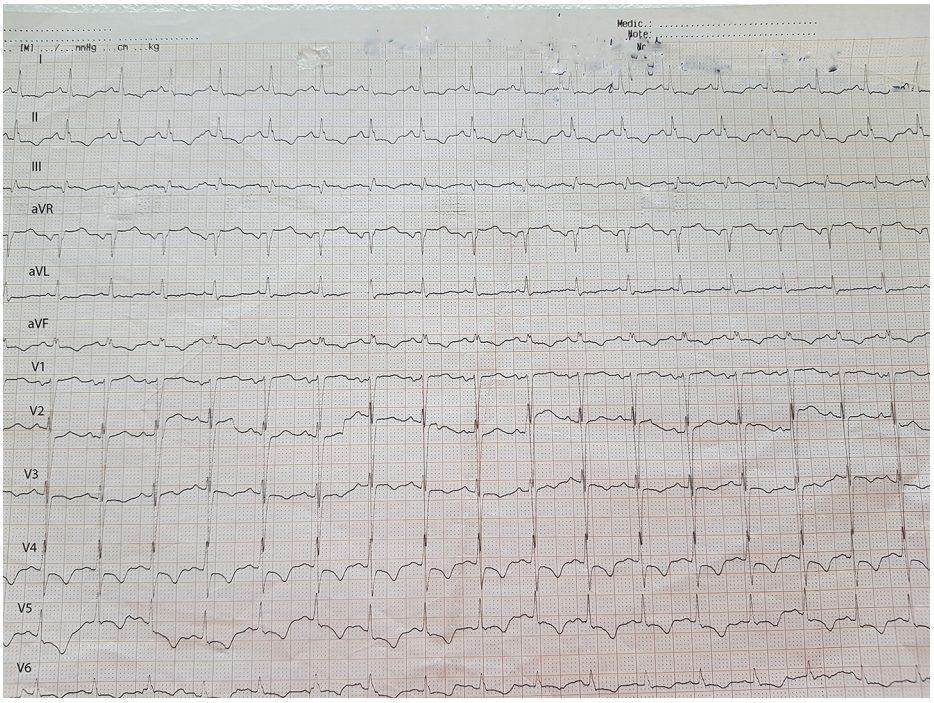
LV = left ventricular

FIGURE 1 Computed Tomography Pulmonary Angiogram



Opacification defects affecting both pulmonary arteries **(arrow).** A = anterior; L = left; P = posterior; R = right; W = width; L = level.

FIGURE 2 **12- Lead Electrocardiogram at Presentation**



Sinus rhythm with negative T waves in leads I, II, III, aVF, and V_3 to V_6.

MANAGEMENT

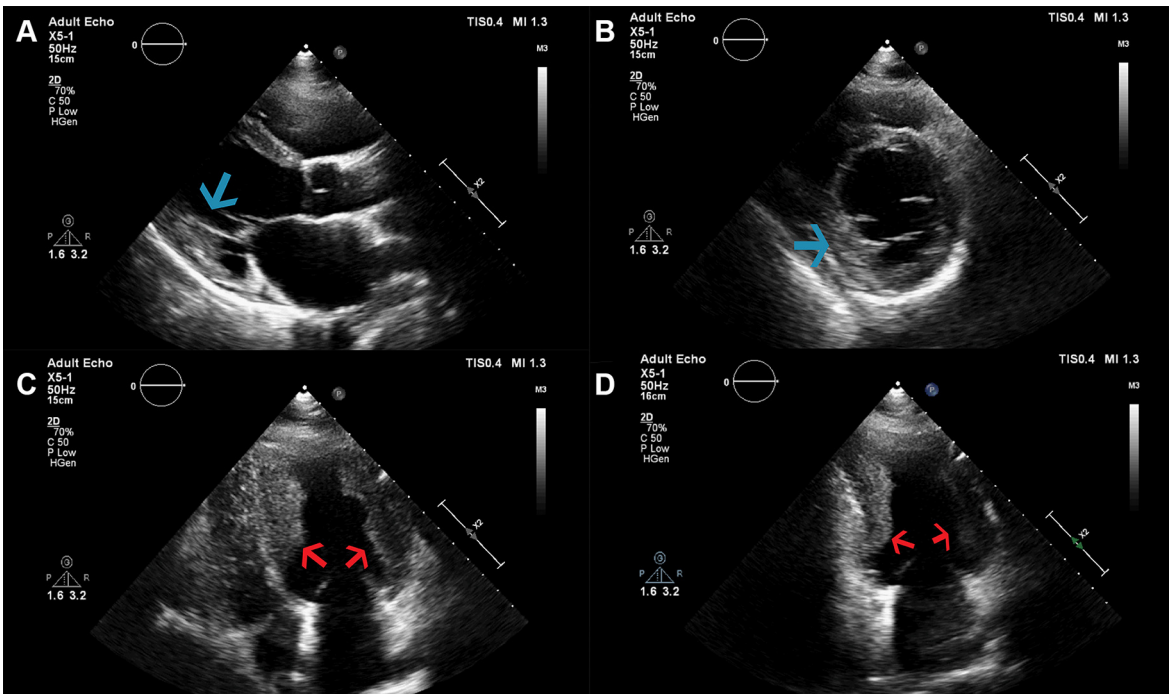
With the serological test results still pending, the patient was discharged on oral corticosteroid therapy (methylprednisolone, 32 mg/day with tapering), rivaroxaban, and beta-blockers. Serological tests returned immunoglobulin G positive for *Strongyloides stercoralis,* and the patient was readmitted for oral ivermectin for 7 days while the corticosteroid therapy was discontinued.

DISCUSSION

Eosinophilic myocarditis is a rare type of acute myocarditis. Conversely, cardiac involvement is common in cases of sustained severe hypereosinophilia (1). Eosinophilic myocarditis is caused by eosinophilic infiltration and granulomatous activation (2). Three stages of the disease have been described: the acute necrotic and inflammatory phase, the thrombotic phase, and the late fibrotic phase (2,3). During the necrotic phase, eosinophil infiltration can be found in the endocardium, the subendocardium, and the myocardial vessels. Eosinophilic degranulation may cause apoptosis and necrosis, and patients may present with acute heart failure requiring mechanical circulatory support (4). During the thrombotic phase, sustained infiltration of the myocardium and the subendocardium can also be observed, but the phase is characterized by the formation of mural thrombi containing activated eosinophils across the destroyed endocardium (2,3). If the condition is untreated, inflammation can lead to permanent fibrosis, causing restrictive cardiomyopathy, conduction abnormalities, or secondary mitral regurgitation.

Our patient was in the second thrombotic phase, as demonstrated by the thrombi. Neurological symptoms were explained by emboli to the central nervous system from the left ventricle. Eosinophilic myocarditis was also complicated by a life-threatening pulmonary embolism. Because right cardiac chambers were unaffected, pulmonary embolism could not be explained by emboli from the right ventricle, and

FIGURE 3 Transthoracic Echocardiography



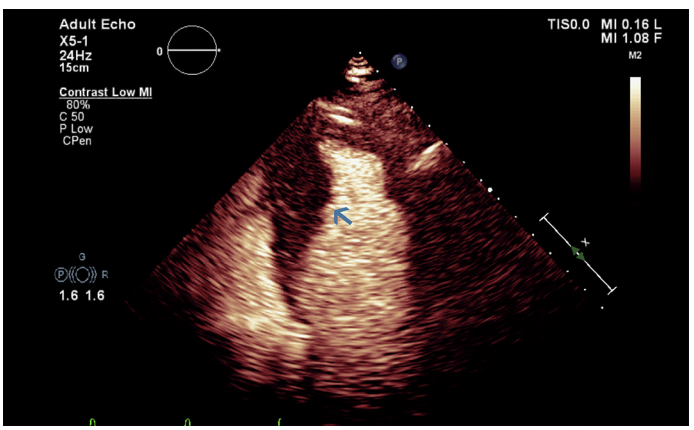
(A) Long-axis, **(B)** short-axis, **(C)** apical 4-chamber, and **(D)** apical 2-chamber views. The additional tissue affects the basal segments of the inferolateral wall **(blue arrows).** In the apical views, there is increase of the left ventricular wall thickness in the middle and apical segments. The echogenicity of the inflammatory tissue **(red arrows)** is different from that of the unaffected myocardium.

they probably resulted from hypereosinophilia-induced thrombophilia. The latter had led to deep vein thrombosis, as demonstrated by Doppler sonography.

Eosinophilia can be mild (eosinophils <1,500/mm^3), moderate (eosinophils 1,500 to 5,000/mm^3), or severe (eosinophils >5,000/mm^3), and severe eosinophilia is most commonly associated with tissue infiltration (5). However, eosinophilic infiltration has been described even in the absence of peripheral eosinophilia (6). Causes of eosinophilia associated with eosinophilic myocarditis include reactive eosinophilia secondary to drug reaction, infections, neoplasms, and rheumatic and inflammatory diseases. An idiopathic myeloproliferative disorder causing eosinophilia is described as a hypereosinophilic syndrome (4,7).

In the case presented, although results of stool examinations were negative, the diagnosis of reactive eosinophilia resulting from *Strongyloides*

FIGURE 4 Contrast-Enhanced Transthoracic Echocardiography



Perfusion of the inflammatory tissue is lower compared to the normal myocardium and contains areas without perfusion **(arrow).** The latter finding is consistent with left ventricular thrombi.

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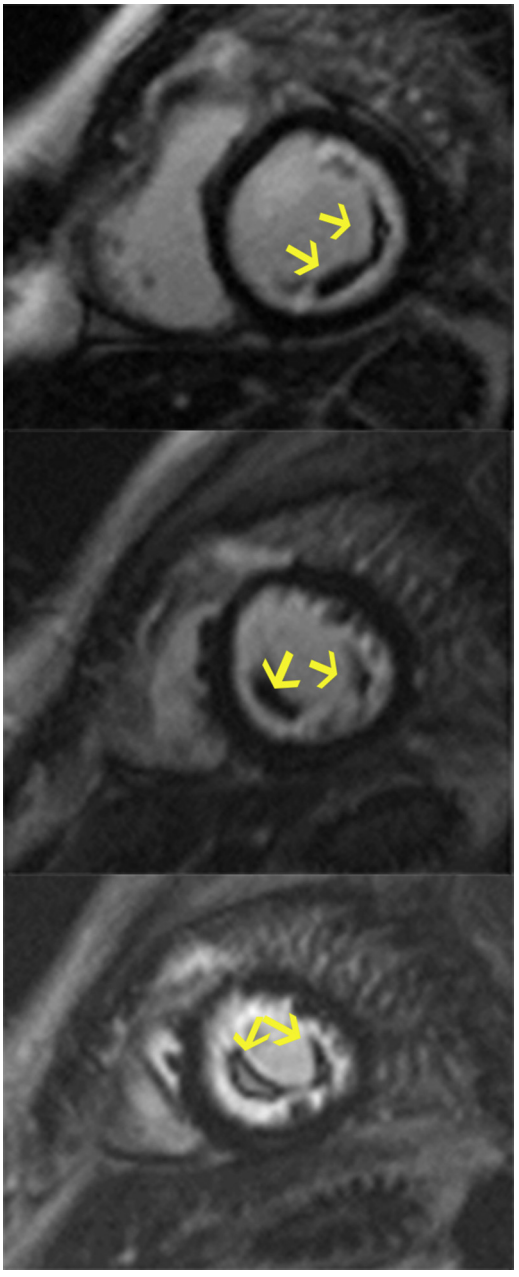
FIGURE 5 Cardiac Magnetic Resonance



Short-axis late gadolinium enhancement images of the **(top)** basal, **(middle)** middle, and **(bottom)** apical segments. Note the almost circumferential subendocardial enhancement, including the papillary muscles, as well as the mural thrombi within the left ventricle **(arrows).** The right ventricle appears unaffected.

stercoralis infection was made on the basis of serological tests and improvement of myocarditis after treatment.

In echocardiography, thickness of myocardial walls because of inflammation and eosinophil infiltration and apical obliteration caused by thrombi are common findings (8,9). Pericardial effusion is also common. Although basal myocardial segments are not usually affected, regurgitation of the mitral valve can be caused by fibrosis of the chordae tendineae (9). CE is helpful when trying to detect thrombi or to distinguish thrombi from surrounding inflammatory tissue (8).

CMR can identify the extend of endomyocardial involvement and can be used for the initial diagnosis as well as in reassessment (10). For definite diagnosis, tissue biopsy is required, but it was not performed because of the typical clinical and imaging data, as well as the high complication rate of this procedure.

FOLLOW-UP

At the 3-month follow-up, the thickness of the abnormal tissue had decreased, thrombi had disappeared, the mitral valve was unaffected, and fibrosis was absent (**Figure 6,** Videos 6 and 7).

CONCLUSIONS

In our case, cardiovascular imaging revealed the diagnosis of myocarditis induced by inflammatory tissue, detected the LV thrombi, and explained the patient's clinical presentation. CMR in particular offered the diagnosis to the extent that confirmation with tissue biopsy was not considered mandatory from a clinical perspective. Echocardiography and CMR also demonstrated decreased myocardial involvement at 3-month follow-up.

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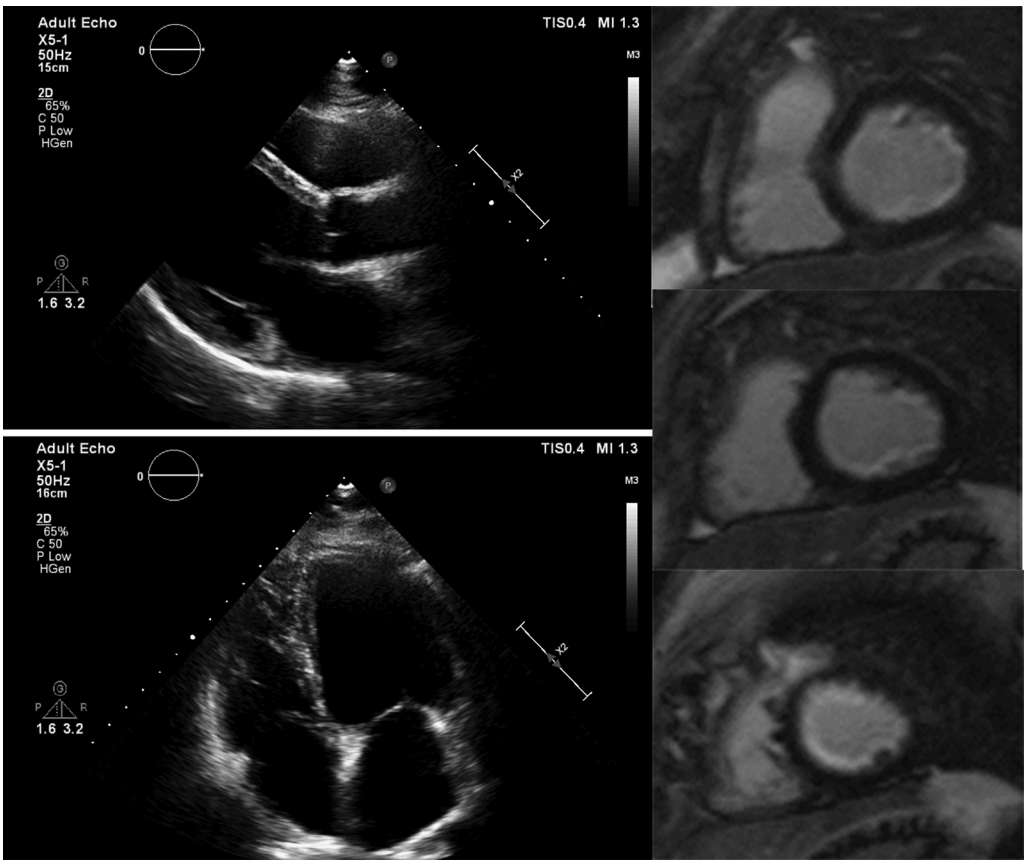
FIGURE 6 Echocardiography and CMR at 3-Month Follow-Up



(Left) The thickness of the additional inflammatory tissue (echocardiographic images) and **(right)** the late gadolinium enhancement (cardiac magnetic resonance [CMR] images) have decreased. In addition, left ventricular thrombi have disappeared.

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KEY WORDS cardiac manifestations, cardiovascular imaging, eosinophilia, inflammatory myocarditis, parasitic infection

APPENDIX For supplemental videos, please see the online version of this paper.